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NINTH ANNUAL REPORT

1875-77

OF THE

BOARD OF HARBOR COMMISSIONERS.

635856
9th Mass,

JANUARY, 1875.

BOSTON:
WRIGHT & POTTER, STATE PRINTERS,
79 MILK STREET (CORNER OF FEDERAL).
1875.

HOUSE...... ......No. 61.

NINTH ANNUAL REPORT

OF THE

BOARD OF HARBOR COMMISSIONERS.

JANUARY, 1875.

3061

BOSTON:
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REPORT.

To the Honorable Senate and House of Representatives of the Commonwealth of Massachusetts.

The Board of Harbor Commissioners respectfully submits their Ninth Annual Report.

South Boston Flats.

In submitting its last Annual Report, the Board announced that the negotiations with the Boston-Wharf Company, the Boston & Albany Railroad Company and the city of Boston, of terms of coöperation in the improvement of the South Boston flats were complete and had been consummated; and made an historical statement, quite in detail, of the objects, actions and negotiations connected with this great measure of harbor improvement, up to the date of their report.

During the past year the duties of the Board, in connection with this matter, has been mainly confined to action bearing upon the practical work of carrying out the projected improvement.

Satisfactory progress has been made in the construction of the sea-walls inclosing that part of the flats which the Commonwealth has undertaken to improve, viz., the twenty-five acres lying at the north-westerly corner of the flats and bordering upon Fort-Point Channel and the main channel of the inner harbor.

Particular regard has been paid to the *quality* of the work. These sea-walls are to be retaining-walls for solid filling, upon which heavy superstructures may be built and heavy material stored; and, as they also serve the purpose of wharf-faces, bordering upon deep channel-ways, which vessels of the largest class can approach and where they can land their cargoes, it is important that not only the plan of the structure itself, but the manner of its construction, should be of the first class. The execution of this work, according to the plans adopted by this Board, so far as it has progressed, under the able supervision of Edward S. Philbrick, Esq., is deserving of special notice. The Board is gratified to state, that the light sea-wall, now completed along the border of the Fort-Point Channel, is equal, if not superior, to any other structure of its kind in the waters of the Commonwealth. And no work, to their knowledge, has been undertaken, in any harbor of our country, superior in its design or workmanship to the plan and execution of the heavy sea-wall, so far as it has progressed.

About 160,000 cubic yards of material have been dredged, partly from the trenches of the sea-walls and partly from the flats outside of them. This material has been deposited as filling upon the twenty-five acres of territory within the sea-walls before alluded to,—serving, as contemplated in the general plan, the double purpose of utilizing the flats and deepening the harbor.

In order to afford access to the ground of work, so that the stone-vessels might discharge their supplies in place, without delay, or regard to the particular stage of tide, and also as a measure of systematic progress, the dredging—after the trenches were first dug—has been so executed as to give a channel-way along the outer line of the sea-walls, with " cuts " through the flats, somewhat tangent to the circular portion of the sea-wall,—one cut leading into the deep water of Fort-Point Channel and one into the deep water of the main channel of the inner harbor.

The set of the tide in this passage-way, through what was before shallow flats, gives evidence of the accuracy of the determination of the line of flowage with which the precise location and trend of the sea-wall was intended to coincide.

The amount of dredging still to be done, in order to complete the filling of the twenty-five acres enclosed by the sea-walls,—reserving a space for a dock,—is estimated by Mr. Philbrick at about 435,700 cubic yards.

After preparing the pile foundation, the masonry-work of the light sea-wall was begun, in March, 1874, and has been successfully completed. This wall extends from the boundary of the flats belonging to the Boston-Wharf Company to the junction with the heavy sea-wall, and is 641 feet in length.

In April, 1874, work was begun upon the heavy sea-wall. Most of the rubble foundation has been laid from the end of the light sea-wall to the proposed dock,—being about 765 feet in length and containing about 12,000 cubic yards of material.

In September the work of laying the cut-stone for the wall proper was commenced, and is still in progress. About 1,105 yards of this masonry has already been laid, mostly in the lower courses.

The estimated value of work already done is . .	$155,000 00
Value of work yet to be done, ...	445,095 00
Total cost of work when finished, . . .	$600,095 00

A report to the Board by Mr. Philbrick is appended, together with a sketch showing the location of the work, the extent and position of the light and heavy sea-walls, and of the area of flats which have been dredged away, indicated by the shaded cross-lines, with the general depth of water attained, shown by the figures within these shaded lines.

EASTERN-AVENUE BRIDGE.

It has been the steady policy and persistent effort of the Board to improve the navigation and provide the greatest practicable maritime facilities for Boston harbor. To this end, it has given its closest attention and best judgment, and brought its best knowledge and experience to every work which has come before it for consideration and action, and has asked for legislation to support it where cases have required it.

When the time came in the development of the South Boston flats improvement to build a bridge in the line of Eastern Avenue, the Board had hope that, in thus connecting the territory of the Commonwealth with the commercial centre of its capital, one example might be given of a structure which should have the best features of public advantage; and as no parties were so much interested in the question as the city and the State, that the subject would be treated on the broadest basis of public utility and comprehensive foresight. The Board, as representatives of the State, and the city, through its Street

Committee and Engineers, were in harmony as to the best plan of bridge practicable to build, when official action on the part of the Board in relation to this matter was interrupted by counter-action from other parties.

The following documents and correspondence explain the case and the position of the Board in regard to it:—

COMMONWEALTH OF MASSACHUSETTS.

HARBOR COMMISSIONERS' OFFICE,
8 PEMBERTON SQUARE, BOSTON, October 19, 1874.

To the Honorable Committee on the Streets of the City of Boston:

GENTLEMEN:—The Board of Harbor Commissioners has received from the Joint Committee of the City of Boston on Streets, a copy of the following vote:—

"IN JOINT COMMITTEE OF THE CITY COUNCIL ON STREETS,
October 10, 1874.

Whereas, The present grade of Eastern-Avenue Bridge was established by the City of Boston upon the recommendation of the representatives of the State; and

Whereas, The city is now urged by other representatives of the State, and by other parties in interest to reduce the grade; and

Whereas, The owners of property in the South Boston flats are the parties mainly interested in securing any change in the grade as at present established; therefore

Voted, That if it appears that the representatives of the State and the other parties interested desire a reduction of the grade, and the city will be fully indemnified for any expenses growing out of the same, this Committee will recommend the City Council to reduce the grade to twenty-one feet above mean low water at the centre of the draw."

The Board has received from the Secretary of the Commonwealth a copy of the following order of the Governor and Council:—

COMMONWEALTH OF MASSACHUSETTS.

COUNCIL CHAMBER,
BOSTON, October 15, 1874.

In Council: *Ordered*, That the Council recommend to the Harbor Commissioners to arrange with the City of Boston to change the grade of the bridge in Eastern Avenue, over Fort-Point Channel, from twenty-six feet to twenty-one feet above mean low water, providing the alteration can be made without expense to the State.

Order adopted October 15, 1874.

OLIVER WARNER, *Secretary.*

SECRETARY'S DEPARTMENT, October, 16, 1874.

A true copy.

OLIVER WARNER, *Secretary of the Commonwealth.*

In view of such action, this Board submits a brief statement of the principal considerations that have governed its past course and will determine its future action in relation to the grade of Eastern-Avenue Bridge. This bridge is to be built over a navigable stream, teeming with vessels passing to and fro, and flowing through a populous commercial city. Two lines of traffic must cross each other's path: the one by the bridge, and the other by water. One must wait for the other, if both are to be maintained, and the adjustment of these conflicting interests to be secured by reducing as much as possible the delays caused by the passage of vessels through the draw across the line of the highway. The delay is caused by the opening and shutting of the draw and by the passage of the vessel through.

Relief, then, must come from increasing the rapidity of the movement of the draw, and of the vessel passing through it. Rapidity of movement in the draw may be secured by making it narrow and light, and giving it a perfect poise, as is done in Chicago.

When the draws are made wide and ponderous, steam may be applied, and this is the method last employed in Boston. Increased speed in passing a vessel through the draw is secured by applying the power of a steam-tug. If, however, the draw must be opened for the steam-tug on its return passage without a vessel, all the saving that is made by the rapid passage of a vessel through the draw is lost by the increased number of times the draw must be opened for the passage of tugs. To retain this saving, the draw must be so built that the tug, by lowering its smoke-stack, can pass under it when closed, at all stages of the tide. This is the system which the city of Chicago has had the intelligence to apply to Chicago River. Twenty-seven streets are carried over this river, some of them in the heart of the city, and the whole detention to travel over these bridges, by the passage of a vessel, has been reduced to a period varying from one-half minute to a minute and a half. There, no vessel is allowed to pass a draw without a tug, and no draw is opened for a tug alone.

The draw in Eastern-Avenue Bridge, it is safe to estimate, will be opened fifteen thousand times a year,—say an average of fifty times every day, not reckoning Sundays. Five minutes is the average detention on the bridge with the best draws in Boston, when the vessel drifts through stem foremost on the tide, or is hauled through by hand. Consequently, the delays of traffic over this bridge, caused by vessels passing through this draw, would amount to five hours daily, unless the rapidity of the passage of the vessel through the draw is in some way accelerated, and the steam-tug is the only appliance which it has thus far been found possible to use for this purpose. The lowering of the grade to this bridge has seemed to the Board to involve the perpetuation of this evil. It cannot be predicted what will be the amount of traffic that will pass over this bridge. If the amount for a single day over the Federal-Street Bridge four years ago is any criterion, that was represented by five thousand eight hundred and sixty teams, and seventeen thousand eight hundred and seventy-three foot passengers, not to mention seven hundred and sixty-three horse-cars with their thirteen thousand passengers.

So great and exasperating a grievance were these delays at bridges over Fort-Point Channel felt by the people of South Boston to be, that their representative in the State Senate, in the year 1871, introduced in the legislature an order of inquiry contemplating the shutting up of all the draws on Fort-Point Channel, and stopping all the navigation of this channel and South Bay.

The violence of such a measure will be appreciated when it is considered that the extinction of Fort-Point Channel and South Bay amounts to the destruction of a water-front in the midst of the city, three and a quarter miles in linear extent, of over four millions square feet of wharf property in actual use, to which are annually brought cargoes representing a value of over twenty million dollars, and the loss of navigable waters over which some ten thousand vessels, of every variety of tonnage, from nine hundred tons down, annually pass. This Board earnestly resisted the measure.

The joint committee of the legislature on harbors, to which this order of inquiry was referred, reported against the closing of these draws, or applying to Congress for authority to do so. In its report on the subject, the committee use the following language: "The order, however, did not contemplate immediate action, but rather first to obtain the consent of Congress, and act under it when the proper time arrived; in the meantime *bridging the streams* (*i.e.*, Charles River and Fort-Point Channel), on *some comprehensive plan of* ELEVATED STRUCTURES, and experimenting with tunnel and other plans. The existing structures are too low at high tide to allow the passage of even a scow or barge; so 'lightering' is quite out of the question." While it remains possible to find a remedy in any other manner, the commerce of the streams should not be disturbed. *Elevated bridges*, basin-draws, tunnels, and other improvements, have been projected and successfully used elsewhere. "It should seem that ingenuity has not yet been overtasked or exhausted here."

The committee reported a Resolve instructing this Board "to consider what relief can be provided for the traffic across said river and channel by a system of *improved bridges, the use of steam in moving vessels and draws*, or by any other means, and report to the next general court, with plans and estimates"; and this Resolve was passed by the legislature. It is remarked that the chairman of the committee who made this report in favor of "a comprehensive plan of elevated bridges" over Fort-Point Channel and Charles River, was the senator from South Boston who introduced the order looking to the permanent closure of the draws over those channels, and might well be supposed to represent the judgment of the people of South Boston in respect to the remedy of this grievance; and, further, that an eminent civil engineer and constructor of bridges, Mr. Parker, of Lancaster, was a member of this able committee.

This Board reached the same conclusion, that "a comprehensive plan of elevated bridges," which would allow the passage of steam-tugs under them when closed, was one of the necessary measures for remedying the evils complained of, and so reported in its Sixth Annual Report to the legislature. It recommended, also, that, when such bridges are built, vessels should not be allowed to pass through them without a steam-tug, and that the draw should not be opened for the passage of a tug merely. So far as the Board has information, these remedies were accepted by all parties as satisfactory. It has ever since been the purpose of the Board to apply them as opportunity offered, believing that such a policy had received the sanction of the legislature and the public.

Accordingly, when the grade of Eastern-Avenue Bridge was under discussion in the city government, this Board urged upon the city of Boston the considerations which led it, in its Sixth Annual Report, to recommend a high grade for all future bridges to be built over Fort-Point Channel; and grade twenty-six was voluntarily adopted by the city government for the surface of the draw.

The slope on each side makes the hardly appreciable grade of fourteen inches in a hundred feet, and seemed to the Board entirely unobjectionable; while the fact that such a grade to the bridge would make it necessary for the Boston-Wharf Company to be at some expense in adjusting the grade of its territory to the high grade of its bridge, did not seem a sufficient reason for surrendering the public advantage to be secured by beginning a "comprehensive plan of elevated bridges," in connection with the regulations for the navigation of the channel already indicated. But, on a reconsideration of this subject by the governor and council, since their approval of the present grade of Eastern Avenue, it appears, from their order already communicated, that these views of the Board have not been reaffirmed by them.

In a case of this character, involving merely a question of public policy, the Board consider that a proper deference to the authority of its official superiors requires that it should yield to the order of the governor and council, according to its terms.

The Board, therefore, notify the city committee that, in case the city of Boston shall see fit to submit to this Board, plans for the construction of Eastern-Avenue Bridge, at grade twenty-one instead of grade twenty-six for the surface of the draw, this Board will—subject, however, to the approval of the governor and council—sanction the plans and authorize the structure.

Should the city committee be of opinion that it is desirable to change the grade of Eastern Avenue, this Board would make one suggestion for its consideration.

The change, if made, will have been made on the application, and largely for the benefit of, the Boston-Wharf Company. This company has always, heretofore, refused to meet the demands of the city of Boston and of the Commonwealth for the right—should the public interest require—to have a street from Northern Avenue to Eastern Avenue, over its territory, between B Street and Fort-Point Channel. When so much consideration is paid to the interests of this corporation, the Board would suggest that this slight concession, sought in vain heretofore, in any satisfactory form, by the city and the State, should now be insisted upon. The Board transmit herewith the reports of the Legislative Committee on Harbors, of the year 1871, in relation to traffic over Fort-Point Channel and South Bay, and the Sixth Annual Report of this Board to the legislature, for the use of the committee.

JOSIAH QUINCY, *Chairman.*

COMMONWEALTH OF MASSACHUSETTS.

COUNCIL CHAMBER, BOSTON, December 28, 1874.

IN COUNCIL: *Whereas*, The Board of Harbor Commissioners, in its communication of November 14, 1874, have submitted to the governor and council, modified plans for the reduction of grade for Eastern-Avenue Bridge from twenty-six feet to twenty-one feet, and have also called our attention to the expediency of requiring the Boston-Wharf Company to consent to the laying out by the Commonwealth, or city of Boston, of a street of convenient width, from Northern Avenue to Eastern Avenue, over the territory of said company, without compensation for the land so appropriated; and

Whereas, The joint committee on streets of the city of Boston, have sent a communication to the governor and council, dated December 17, 1874, approving the modified plans reducing the grade, as soon as the Boston-Wharf Company will give a bond or obligation to indemnify the city for all damages and expenses on account of said reduction of grade:

It is ordered, That said modified plans be approved, upon condition that the Boston-Wharf Company consent to the laying out by the Commonwealth, or the city of Boston, of a street of convenient width, from Northern Avenue to Eastern Avenue, over the territory of said company, without compensation for the land so appropriated. And also upon condition that the Boston-Wharf Company shall give bonds to the State of Massachusetts, through its harbor commissioners, and to the city of Boston, to indemnify each of them for all damages and expenses on account of said bridge, or the reduction of the grade thereof.

Order adopted December 28, 1874.

OLIVER WARNER, *Secretary.*

SECRETARY'S DEPARTMENT, BOSTON, December 29, 1874.

A true copy. Attest, OLIVER WARNER,
Secretary of the Commonwealth.

COMMONWEALTH OF MASSACHUSETTS.

COUNCIL CHAMBER, BOSTON, January 5, 1875.

IN COUNCIL: *Whereas*, A communication has been received from the joint committee on streets of the city of Boston, dated January 1, 1875, informing the governor and council that the Boston-Wharf Company have given satisfactory assurances that the city will be indemnified for all damages on account of the grade of Eastern-Avenue Bridge, and that the city engineer is authorized to order the work to proceed as soon as the modified plans have been approved by the state authorities; and

Whereas, A hearing was granted upon the request of the Boston-Wharf Company on the 4th instant, to which the harbor commissioners and the joint committee on the streets of the city of Boston were invited; the Boston-Wharf Company desired to be relieved from the conditions contained in the order of the governor and council of December 28, 1874, concerning the laying out of a street between Northern Avenue and Eastern Avenue, without compensation for land so appropriated.

It appeared that the proposed street would not be needed at present, and the city of Boston making no request in regard to it,

It is ordered, That the conditions contained in the order of December 28, 1874, concerning the appropriation of land for streets, without compensation, be cancelled;

And it is also ordered, That in consideration of the communication from the joint committee on streets of the city of Boston, dated January 1, 1875, above mentioned, it is also ordered that the condition relating to the bond to the city of Boston, be cancelled, and it is now ordered, that the said modified plans be approved, upon condition that the Boston-Wharf Company execute an agreement to save the Commonwealth harmless from all damages on account of Eastern-Avenue Bridge, or the reduction of the grade thereof; said agreement to be satisfactory to the attorney-general.

Orders adopted January 5, 1875.

OLIVER WARNER, *Secretary.*

SECRETARY'S DEPARTMENT, January 6, 1875.

A true copy.

OLIVER WARNER.
Secretary of the Commonwealth.

COMMONWEALTH OF MASSACHUSETTS.

HARBOR COMMISSIONERS' OFFICE,
8 PEMBERTON SQUARE, BOSTON.

Whereas, By license of this Board, dated April 15th, 1874, the city of Boston was authorized to build Eastern-Avenue Bridge across Fort-Point Channel at a grade of twenty-six (26) feet above mean low water at the surface of the draw; and, subsequently, the city of Boston submitted to this Board for their approval a modification of said plan of said bridge, as described in the said license of April 15th, 1874, making the grade of the surface of said bridge at the draw twenty-one feet instead of twenty-six feet above mean low water; and *whereas*, the governor and council recommended, October 15th, 1874, to this Board a change of the grade of the bridge, in accordance with said modified plan, and by their further action of January 5th, 1875, communicated to this Board, have indicated that said modified plan, changing the grade of said Eastern-Avenue Bridge to twenty-one feet above mean low water at the surface of the draw, will be approved by them, provided, that the Boston-Wharf Company execute an agreement, to save the Commonwealth harmless from all damages, on account of the reduction of such grade, satisfactory to the attorney-general; and, *whereas*, said agreement satisfactory to the attorney-general has been executed to the Commonwealth:

Now, therefore, the said city of Boston is hereby authorized, subject to the approval of the governor and council, to proceed and construct said Eastern-Avenue Bridge, at a grade of twenty-one feet above mean low water, at the surface of the draw, in conformity to the foregoing license, and the plan filed in this office, and numbered 249, making the changes in constructing said bridge, that are necessary to be made, on account of the reduction of said grade to twenty-one feet as aforesaid, which are shown in red ink on plan No. 209, approved by this Board, April 15th, 1874.

In witness, whereof, a majority of the Board of Harbor Commissioners have hereto affixed their signatures this eleventh day of January, A. D. 1875.

(Signed.)

JOSIAH QUINCY.
F. W. LINCOLN.
J. N. MARSHALL.
W. T. GRAMMER.
ALBERT MASON.

CHARLES-RIVER BRIDGES.

When the question of widening the draw-way openings in the Charles-River bridges was before the legislature, in its session of 1869, so as to have them conform to the increased size and width of modern vessels, the Board made a very careful study of the subject. The location and aligument of the bridges, the outlines of the channel, and the complicated currents which struggle through them, were made a matter of thorough investigation. With a system of new and wider draws, the question of the location of the draw in each particular bridge was carefully considered.

As the result of this study, the present plan of a straight pathway through the bridges was devised, as giving the best facilities for the rapid and convenient passage of vessels through them, and causing the least detention to the railroad, wagon and foot passenger transit over the railroad and city bridges which the case admitted. In the interest of the railroad transit over the bridges, this line of the passage-way was thrown as far toward the centre of the river and from the Boston shore as the character of the channel and the existence of shoal ground along its northern margin would admit, so as to give the greatest distance practicable between the depots of the various railroads on the Boston side and the draws.

Promptly following the passage of the Acts requiring these improvements to be made, the Bridge Commissioners commenced operations in widening the passage-ways in Charles River and Warren bridges. The Fitchburg and other railroad companies also took early action in carrying out the requirements of the law. The Boston & Lowell Railroad Company, in September, 1874, commenced to open a new passage-way through their freight-bridge, of the width and in the location prescribed. This company have made a valuable improvement in part of the main bridge, in addition to the changes necessary in building the new draw. This improvement consists in a reconstruction of the pile-piers of the bridge, for a distance of one hundred and sixty-five feet eastward and one hundred and seventy feet westward from the new draw,—the new piers conforming or coinciding with the line of tidal currents. This work is now in process of construction, and will soon be completed.

The Bridge Commissioners have completed the reconstruction of Cragie Bridge, so as to improve the flowage, and have built a new draw. They have also improved the working of the old draw of West-Boston Bridge, and have in contemplation the building of a new and wider draw in this bridge during the coming season. In both of these bridges, steam-power has been applied to move the draws.

The Board is, therefore, happy to announce that, with the opening of navigation and the resumption of the business of the coming spring, this improved channel, or passage-way, though all the bridges, of a width and depth sufficient to admit a larger class of vessels than heretofore engaged in its navigation, will be open, from the waters of the outer harbor to the inner basins of Charles River.

CHARLES-RIVER BASINS.

Important plans for the development and improvement of the basins of Charles River, between Cragie Bridge and Brookline Bridge were brought before the Board for their consideration and action during the past year.

These basins, and the water-front of Cambridge, have shared in the increased demand for maritime facilities which Boston finds it necessary to provide. The improved access to these waters, afforded by the wider and more convenient passage-way to them, has stimulated this development.

Plans for the improvement of the water-front of Cambridge, between Cragie and West Boston bridges, were presented by Messrs. James A. Woodbury, Solomon A. Woods and Fred. Pope, asking for the occupation of a large area of flats, upon some practicable and feasible basis of compensation. Many hearings were given by the Board upon this subject, and a labored and thorough investigation of the questions involved in the measure, instituted.

The magnitude of the proposed scheme may be better understood by a few statistics.

The area of flats intended to be filled, amounted, with ground already filled, to about 2,406,235 square feet, equal to about fifty-five acres. The displacement of tide-water which this filling would occasion, was equal to about 802,078 cubic yards.

The value of these flats, when filled, with the expense of sea-walls, filling, etc., would not be sufficient to induce any private party to make the improvement, if the additional tax of thirty-seven and one-half cents per cubic yard were added to it, as a moneyed compensation for the tide-water which would be displaced.

The case submitted, therefore, brought at once before the Board most important questions, affecting the improvement and development of the harbor, as well as its protection and preservation.

After full consideration of the question of maintaining the tidal reservoir capacity of the basin between Cragie and West Boston bridges, the Board decided that it was not expedient to do so, provided proper and sufficient compensation for such loss of capacity as it might sustain, should be made, as an equivalent for the encroachment. The Board devised and authorized the following plan, for the improvement of these basins of Charles River.

The removal of the shoal immediately above West-Boston Bridge, which obstructs the channel near the draw. The excavation of a channel through the upper basin, between West Boston and Brookline bridges, of sufficient width and depth for the requirements of its navigation. The dredging away of the surface of the flats within this basin, outside of the harbor lines, which lie between the channel and the mill-dam, and belong to the Commonwealth, so that there shall be a film of water over these shoals, instead of bare flats, so long an objectionable and repulsive feature of the basin, at all stages of the tide. Also the removal of flats in the lower basin, between West Boston and Cragie bridges.

The amount of dredging, required in the fulfilment of this plan, was equal, in cubic yards, to the displacement of tide-water occasioned by the filling.

Thus has been inaugurated during the past year, a large scheme of improvement, of the upper basins of the harbor; not for commercial ends alone, but including sanitary and æsthetic features also.

"JUNCTION SHOAL," OFF CONSTITUTION WHARF, IN BOSTON HARBOR.

The Board, in its report of last year, expressed the opinion that the income of the compensation fund for Boston Harbor, accruing during the year 1874, might be advantageously applied in removing such portions of the shoal off Constitution Wharf as interfere with the manœuvring here of steamers of the largest class, and recommended that the legislature authorize the Board to make such expenditure. This authority was given by the following Act (chap. 304 of the Acts of 1874) :—

Be it enacted, etc., as follows :—

The board of harbor commissioners is authorized to contract for the dredging off a portion of Junction Shoal, in Boston harbor, in the neighborhood of Constitution wharf, in such locality as said board shall designate, to a depth not exceeding twenty-three feet at mean low water; and said board may authorize the use of the material so dredged for filling the Commonwealth's flats at South Boston, at the junction of the main and Fort-Point channels, or elsewhere. The income from the compensation fund for Boston harbor, received during the year eighteen hundred and seventy-four, and the receipts, during such year, from assessments for compensation for tide-water displaced, which would otherwise be paid into the said compensation fund, shall be used to pay for such dredging to an amount not exceeding fifteen thousand dollars, which sum, derived from the sources aforesaid, and no other, may be allowed and paid for such dredging, and the same is hereby appropriated.

No such contract shall be made without the approval of the governor and council. [*Approved June* 4, 1874.

In the pursuance of this measure the Board made further surveys of the ground in question, and intended during the last summer to have executed the necessary dredging. The season, however, became so far advanced before it was practicable to commence this work, that the Board had doubt concerning its satisfactory completion during favorable weather. It was, therefore, determined to postpone the operation of dredging for the season. The Board intends, at an early date next season, to take measures to have this shoal removed, as proposed.

COMPENSATION FUND FOR BOSTON HARBOR.

The following statement represents the amount of the Compensation Fund for Boston Harbor, with the receipts for the year 1874, as collected from the following named parties, for tide-water displaced :—

Cash on hand, January 1, 1874, ...		$88,056 77
Brine & Clark, ...	$32 25	
Proprietors of Liverpool Wharf, . . .	1,496 62	
Boston & Maine R. R. Co., ...	129 56	
Boston & Maine R. R. Co., ...	9 37	
Commercial Wharf Corporation, . . .	10 87	
Benj. Randall, ...	4 99	
Batchelder Brothers, ...	1,109 25	
Malachi Clark	75 00	
		2,867 91
		$90,924 68

LEGAL PROCEEDINGS.

The information by the attorney-general, brought at the relation of this Board, against the Boston & Lowell Railroad Corporation, to restrain it from filling flats in tide-waters of Boston Harbor in Miller's River without authority of the legislature, has been reported for the decision of the full bench of the supreme judicial court, and is still pending.

The decision of this case will settle the legal question whether work begun on flats by an owner merely by virtue of his title to the upland before the passage of chapter 149 of the Acts of 1866, can be continued after the passage of this

Act without authority from the legislature or the Board of Harbor Commissioners. It involves, also, the practical question whether compensation shall be paid for the tide-water of Boston Harbor displaced by such work.

Informations by the attorney-general, at the relation of this Board, have also been brought against the cities of Cambridge and Somerville respectively, to restrain them from filling up the bed of Miller's River between the Boston & Lowell Railroad and Bridge Street, without submitting plans to the Board of Harbor Commissioners for approval. The legal question involved is whether these cities, doing this work under the authority of chapter 304 of the statutes of 1873, were subject to the provisions of chapter 149 of the statutes of 1866. The practical question in these cases, also, is whether compensation shall be paid for the tide-water displaced.

The only mode of enforcing the payment of such compensation in these cases, is to enjoin the work, and so oblige those doing it to obtain the license of the Harbor Commissioners to legalize it. Such a license could not be granted except on the statute of 1866, chapter 149, requiring the payment of compensation for any displacement of tide-water, affecting Boston Harbor.

Resurvey of Boston Harbor by the U. S. Coast Survey.

Pending the changes in the affairs of the Coast Survey, consequent upon the resignation of Prof. Benjamin Peirce from its superintendence, after seven years of distinguished administration, no action has been taken in regard to the communication of the Board, asking the superintendent to "consider the propriety of instituting another series of surveys, covering portions of the upper harbor, and extending it into the lower harbor, as far as he might deem it expedient."

It is the intention of the Board to lay this matter again before Superintendent Carlile P. Patterson, trusting that it will meet with his favorable consideration. The eminent qualifications and physical knowledge of the new superintendent as a hydrographer, will give great value to his counsel and advice in matters relating to the interests of Boston Harbor.

GOVERNMENT WORK BY THE UNITED STATES ENGINEERS IN BOSTON HARBOR AND ON THE EASTERN COAST OF MASSACHUSETTS.

By the courtesy of General George Thom, of the United States engineers, the Board has received a manuscript report of his works upon the coast of the Commonwealth, which will be found in the Appendix. To that part of it which refers to Boston Harbor, the Board would call particular attention, on account of the announcement, by General Thom, that all of the many sea-walls guarding the shores and headlands of the harbor are now *finished*, and in *good order*. These walls have been in process of construction through many years. Some of the earlier works have been injured, by the action of the storms they were intended to resist, and have required repairs, which have been duly made.

Boston Harbor.

Point Allerton.—The total length of the sea-wall at Point Allerton is 1,202½ feet. This wall was finished in May, 1874. The work done upon it, since General Thom's last report was rendered, has been 227.2 feet of wall, with corresponding excavations, earth-filling and granite paving; besides which, 1,005 linear feet of granite apron, and eight jetties, have been built, as a protection to the foundation of the wall against the action of the storms to which this headland of the harbor is exposed. It is with satisfaction and gratification that we feel able to state that this bulwark of the harbor is now secure.

Great Brewster.—The sea-wall on Great Brewster is 2,800 feet in length, is in good condition, and answers well the purpose intended.

Lovell's Island.—The sea-walls upon Lovell's Island have been recently repaired, and are now in good condition.

Gallop's Island.—The sea-wall upon Gallop's Island is 1,745 feet in length. This wall was completed in 1871, but the violent storms to which it was exposed had laid bare its foundation, and rendered necessary works for its protection; 1,555 feet of apron, and eight jetties, have been built for this purpose. This work was completed in April, 1874, leaving the wall in good condition.

North end of Long Island.—The sea-wall on this headland is 2,080 feet in length. It was completed in July, 1874; 541.7 feet of wall, with accompanying excavations, earth-filling and granite paving, with 975 feet of stone apron, and ten jetties, have been built since the date of the last report of General Thom.

Deer Island.—There are three walls upon Deer Island, respectively 1,740, 840 and 420 feet in length. These walls have been recently repaired, and are now in good condition.

The Board cannot speak in too high commendation of the able and systematic manner in which the above-mentioned work has been conducted and completed by General Thom.

Narrows Channel.—The intended improvement of this channel in its course between Brewster Spit, Lovell's and Gallop's Islands, is a project for removing the salient points of Brewster Spit and the south-east and south-west points of Lovell's Island, at an estimated cost of $56,000. Considerable work in the fulfilment of this project has been done under former appropriations. The remaining work, now in progress under the direction of General Thom, is estimated to be completed in June, 1875.

Upper Middle Bar.—For the improvement of this Bar, a project was devised for cutting a channel through it. This channel is to be 23 feet deep at mean low water, 600 feet wide and 2,200 feet long. The amount of excavation made, up to January 1, 1874, was 46,425 cubic yards. Operations were recommenced in April, 1874, since which time, up to January 1, 1875, 39,962 cubic yards of material have been removed. By this work the channel has been opened to a width of 175 feet, with 23 feet of water at mean low water. There is a probability of completing this work to its projected width of 600 feet at an early date.

Nash's Rock.—This obstruction to navigation is, in fact, a shoal, lying between Brewster Spit and Point Allerton. The removal of the highest part of this shoal, so that there would be not less than 21 feet of water upon it at mean low water, would require the removal of about 200 cubic yards of bowlders, shingle, etc., over an area of about 637½ superficial yards, at a cost of $5,000. To give 23 feet of water over the whole shoal, would require the removal of about 16,000 cubic yards of the same material from an area of 9 1/16 acres, at a cost greatly disproportionate to the benefit obtained.

Kelly's Rock.—There are still portions of this rock having less than 23 feet of water over it at mean low water. To remove these portions to the required depth, will require the removal of about 80 cubic yards of rock, at a cost of $5,000.

Sunken Ledge.—This is another obstruction to navigation in the Narrows channel, discovered by Gen. Thom, in 1872. This rock was removed to a depth of 23 feet at mean low water, in September last.

State and Palmyra Rocks.—These rocks are on the southern side of the Lower Middle Bar, and probably belong to the same ledge. Gen. Thom recommends the removal of about 62 cubic yards of this ledge, to a depth of 13 feet at mean low water. This work has been contracted for, and will be done in June, 1875.

Surveys of Sunken Rocks.—Careful surveys have been made in the Narrows channel, but no rocks, other than those already known, have been found. Surveys were made in Broad Sound, east of Great and Little Faun Bar, over an area 1,000 by 500 feet, but no rocks were found having less than 13 feet at mean low water.

The following estimates are made by Gen. Thom for the several works projected for the further improvement of the harbor:—

For the "Narrows channel,"	$46,000 00
For completing channel through the "Upper Middle,"	162,518 00
For removing Nash's Shoal, ...	5,000 00
Completing removal of Kelly's Rock, ...	5,000 00
Removal of State and Palmyra Rocks, . . .	1,500 00
Contingencies, ...	17,276 06
Total, ...	$237,294 06
Amount available January 1, 1875, ...	117,294 06
Additional amount required for completing all the required improvements, ...	120,000 00

Other Work on the Coast of Massachusetts.

Merrimac River.

The appropriations for work under this head, by several Acts of Congress, amount to $110,000.

The work of improvement done under these appropriations, consists in the removal of clay, bowlders, etc., from the Upper and Lower Falls, and Hazeltine Rapids, amounting in all to 13,798.4 cubic yards.

To complete the contemplated improvements there remains only the highest points of some of the ledge at the lower falls to be removed, for which work there are sufficient funds.

In the river, between Newburyport and Haverhill, Gangway Rock, two rocks above Deer Island ledge, rocks at Rocks Bridge and Little Currier Rock, have been removed. Dredging at Currier Shoal has been made and a dike built at Silby's Head.

Newburyport Harbor.

In this harbor South Gangway Rock has been removed, and work commenced on North Gangway Rock. The wreck of the schooner Globe has also been removed.

Gen. Thom estimates for the further improvement of Newburyport Harbor, and the mouth of the Merrimac, the sum of	$22,000 00
And for the river, between Newburyport and Haverhill, the sum of	19,000 00
Total, ...	$41,000 00

Gloucester Harbor.

Ten thousand dollars have been appropriated for improvement in this harbor. With this fund a number of rocks and bowlders have been removed, leaving a balance unexpended of $686.84.

Salem Harbor.

The estimates for the various improvements proposed for this harbor, Gen. Thom states as $48,000. The amount actually appropriated by Congress is $25,000.

Under this appropriation, work was commenced in December last, and was continued throughout the month, by which 9,916 cubic yards of dredging has been done.

Duxbury Harbor.

The appropriations made by Congress for this harbor were $20,000. The work intended being the improvement of the south channel, which extends from the "Cow Yard," in a north-westerly direction, for about three miles. The lower part of this channel, for about two and a half miles, had a width of not less than 200 feet, and a depth of about 11½ feet at mean low water. The upper part was originally narrow and crooked, having a width of not more than 80 feet. This part of the channel has been straightened, and a width of 200 feet given, with a depth of eight feet at mean low water. This work was completed in May, 1874.

Plymouth Harbor.

During the last five years, Congress has appropriated $30,500 for the improvement of this harbor.

This work has consisted in the construction of bulkheads, jetties, and groins, and the planting of beach-grass.

Previous to June, 1874, twenty-three groins of brush and stone, giving a total length of 3,000 feet, and ten groins of brush alone, giving a total length of 534 feet, had been built.

Between June and November, 1874, 3,090 feet of brush and stone groins, and 320 feet of brush groins, and 110 feet of bulkhead, have been built, to strengthen the beach where broken through by the storm of November, 1873.

Thirty thousand dollars is estimated as the sum required for the further improvement and preservation of this harbor.

Wellfleet Harbor.

All the sunken rocks have been removed from the entrance of this harbor, and above, to the extent contemplated.

Provincetown Harbor.

This important harbor has been the subject of various projected and executed works of improvement, for many years, and large sums have been appropriated and expended.

During the past year (1874) $4,817.03 have been expended in protecting and strengthening the outside beach, near the "head of the meadows," which was encroached upon by the gales of November, 1873, and January, 1874, and subsequent gales. Also in increasing the outer end of the stone bulkhead at Long Point. The efficiency of the work upon the outer beach has been most successfully tested by a violent storm, which rushed over the beach and filled the space, in front of the work, to a depth of two or three feet, with sand, adding greatly to its strength.

FLATS AND MARSHES OF EAST HARBOR IN PROVINCETOWN.

The Board stated in its last annual report that the marsh-owners in East-Harbor marshes had refused to settle their claims for damage done to their meadows and marshes by the construction of the state dike across the outlet of East Harbor, for five thousand dollars, the amount first appropriated for this purpose, and to drain the marshes; and that, by reason of such refusal, the Board had taken no further action in the premises.

During the last session of the legislature, however, and after the last report of the Board was made, the East-Harbor parties renewed their claims in hearings before the joint committee on harbors; and the legislature by chapter 34 of the Acts of 1874 passed the following Resolve:—

> *Resolved*, That the board of harbor commissioners is hereby authorized to compromise and settle in behalf of the Commonwealth any demands that seem to the board just, of any persons or corpo-

rations for injuries resulting to meadows, flats and beaches, in Truro and Provincetown, in the county of Barnstable, from the construction by the Commonwealth of a dike across the outlet of East Harbor, or to purchase in behalf of the Commonwealth the fee of said meadows, flats and beaches, or any part of them, and to receive in behalf of the Commonwealth conveyances or releases of the same, or agreements concerning the same: *provided*, *however*, that such settlements, purchases, conveyances, releases or agreements shall be subject to the approval of the governor and council; and that there shall be allowed and paid out of the treasury of the Commonwealth for the purposes of this resolve a sum not exceeding ten thousand dollars; and the harbor commissioners may, in making any purchase of said meadows, flats and beaches, or, after the same have been conveyed to the Commonwealth, make any agreements concerning future occupation of the same, or concerning any rights or interests of persons or corporations in the same which to said board may seem fit and proper, subject, however, to the approval of the governor and council. [*Approved April 21, 1874.*

Owing, partly, to the difficulties of adjusting the matter under consideration, and conferring with all the parties in interest concerning it, the Board has, as yet, come to no definite conclusions, and made no definite arrangements. The parties claiming damages have, however, put their affairs in the hands of Hon. George Marston. Through his instrumentality, the Board have confident expectation of making an early agreement, satisfactory to the Commonwealth and all other parties.

EDGARTOWN HARBOR AND COTAMY BEACH.

The Board is sorry to announce the failure of the attempt which was made by Gen G. K. Warren, in the fall of 1873 to reopen the southern outlet of Edgartown Harbor, through Cotamy Beach.

The Board took an active initiatory part in this matter. It was first appealed to by the town of Edgartown in its corporate capacity, for such aid and action as might lead to measures for the protection and preservation of the harbor. After careful consideration of the subject and a visit to and examination of the locality, the Board petitioned the Superintendent of the Coast Survey for information. This call was cordially and promptly responded to by Superintendent Peirce, who ordered re-surveys, which were made, together with a comprehensive study of the whole subject. The Board also submitted this project to the United States Advisory Council, and received their endorsement of it. The Board further aided in efforts to procure the appropriation of twenty thousand dollars, which was awarded for this work, by memorializing Congress and advocating what it deemed the just and urgent claims of the case. But neither this Board nor those who assisted and advised it were consulted during the entire progress of the engineering work, so that their information is wholly derived from the printed report of Gen. Warren, quotations from the introduction and conclusion of which are given below:—

> *Introduction.*—The improvement designed for the harbor of Edgartown was to be effected by re-opening Cotamy Bay to the ocean by an artificial cut through Cotamy Beach, thus restoring the circulation of the tides in this harbor as it existed prior to the closing of the natural outlet through Cotamy Beach in 1869.
>
> The operations were confined to digging through the beach and through the contiguous shoal in the bay. The work was conducted with care and energy, aided by the most experienced men of this part of our coast whose services we could procure.
>
> The amount of labor expended and material removed were equal to our expectations, and the cut was carried entirely through the shoal and beach.
>
> It was designed to throw it open at the time of a favorable high tide in the bay, but a very feeble tide in the bay occurred at the time we were ready, and the next high tide in the ocean coming with a violent storm broke into the cut. The velocity of the current was very great, as it had a head of at least four feet.
>
> The current rapidly widened the cut, but did not carry the sand out of it, and, on the change of the tide, the ocean-waves closed the opening on that side. Efforts were made afterward to open the cut with the outflow of the bay-tide, but the waves each time closed it up at the period of slack-water. * * * * *
>
> *Conclusion.*—I cannot find ground at present sufficient to justify an appropriation for making the only opening in the beach which I consider practicable. But unwilling to stand in the way of an object which others have thought so desirable and easy of accomplishment, I respectfully recommend an appropriation of $22,000, the original estimate, to be paid to any one who will make the improvement desired; letting it by contract to the lowest bidder,

under sufficient guarantee that he will make a proper effort, and receive compensation upon succeeding.

After a careful study of Gen. Warren's report, the Board,—in view of all the circumstances which attended the failure of the enterprise, the stormy weather, and the small tides which resulted from the lateness of the season,—sees no reason for changing or modifying its former opinion, or doubting the practicability of opening the inlet at a more favorable season, and when the relations of the tides are such as to secure a first outflow towards the ocean, and heartily concurs in the recommendation of Gen. Warren, that the work should be done by contract.

GOVERNMENT WORK BY THE UNITED STATES ENGINEERS ON THE SOUTHERN COAST OF MASSACHUSETTS.

Through the kind attention of Gen. A. A. Humphreys, chief of the United States engineers, the Board has received copies from the original plans of the surveys and works along the southern shores of the State, in charge of Gen. G. K. Warren. These copies of the plans and surveys of the engineers are a valuable acquisition to the archives of the Board.

By the courtesy of Gen. Warren, the Board also received, in December last, printed copies of his report upon the works and surveys above referred to. Gen. Warren's report is too voluminous to be transcribed in full to the pages of our own Report. With the following brief notice of his work extracts will be given from his report in the Appendix:

Hyannis Breakwater.—Ten thousand dollars have been expended in repairs of this breakwater. The west end is in good condition, but the remaining parts are reported as unsafe. Gen. Warren estimates further needed repairs at $15,400.

Wareham Harbor.—Appropriations amounting to $30,000 have been made for this harbor, of which $20,000 have been expended in dredging, to the amount of 46,763 cubic yards, through "Quahaug" and the "Upper" bars, by which means a channel not less than 60 feet wide and nine feet deep at mean low water has been made up to the town. A rock weighing 28 tons has also been removed from the channel. Further work will be needed in order to make the channel 200 feet wide and nine feet deep at mean low water, for which an additional amount of $10,000 will be required.

Taunton River.—Shoals, known as "Blake's Table Rock" and "Sheep Pen" have been removed, and a cut about 25 feet wide and 600 feet long made through "Chobbet Rock Shoal" to the depth of nine feet at mean low water. Additional work of improvement is recommended, the estimate for which is $22,000, which can be advantageously expended in one year.

Edgartown Harbor.—By Act of Congress of June 11, 1872, an appropriation of $20,000 was made for the protection and preservation of this important harbor,—the work contemplated being the restoration of its former southern outlet, by an opening through Cotamy Beach.

Work was commenced, under the direction of Gen. Warren, on July 21, 1873, and continued until October 27, when it was destroyed by the gale of that date. Some slight work was resumed on October 31 and November 6, without results, when the work of opening the beach was abandoned after $18,624.52 were expended. Gen. Warren proposes the use of the remainder of the appropriation for a survey to "ascertain what the injury has been in the last five years, and whether it is not better to dredge at Edgartown than at Cotamy Beach."

Survey of Wood's Hole Harbor.—This survey has resulted in the recommended improvement of removing rocks interfering with the present steamboat navigation, at a cost of $5,000. The further sum of $22,000 is estimated for a more thorough and extensive improvement, which Gen. Warren earnestly recommends for this important passage-way.

Survey of the Harbor of Fall River.—A survey of this harbor has been made, resulting in the recommendation, by Gen. Warren, of improvements which he estimates at $45,000, —$10,000 of which have been appropriated by Congress.

PLANS APPROVED

By the Board of Harbor Commissioners during the Year 1874, for the Erection of Structures in or over Tide-water, and Licenses Granted for such Structures.

1. Road Commissioners of the town of Manchester, for the construction of a stone-and-wood bridge across Edward's Creek. Approved January 7, 1874.
2. Old Colony Railroad Company, to widen its bridge over Fort-Point Channel. Approved January 21, 1874.
3. Robert Crosbie, for leave to build a pile-wharf in East Boston. Approved January 28, 1874.
4. James Buffum, for leave to extend his wharf in Lynn Harbor. Approved February 11, 1874.
5. Weetamoe Mills, for leave to construct a wharf in Fall River. Approved February 18, 1874.
6. Old Colony Railroad Company, for leave to widen its wharf in Fort-Point Channel. Approved March 4, 1874.
7. Horace Cousen, for leave to extend his wharf in Charles River, near Brookline Bridge. Approved March 11, 1874.
8. Edward B. Lane, for leave to extend his wharf and fill flats in Salem Harbor. Approved March 18, 1874.
9. Jarvis R. Nickerson and Washington Robbins, for leave to build a wharf in Cotuit. Approved March 18, 1874.
10. N. H. Bearse, for leave to build a wharf in East Bay, Barnstable. Approved March 18, 1874.
11. William R. Clark, for leave to build sea-walls between Foster's Wharves. Approved March 25, 1874.
12. Boston Gas Light Company, for leave to build a sea-wall on Commercial Point. Approved March 25, 1874.
13. Charles A. Ropes, for leave to extend his wharf on piles in Salem Harbor. Approved March 25, 1874.
14. Eastern Railroad Company, for leave to build a bridge across Prison-Point Bay. Approved April 8, 1874.
15. City of Boston, for leave to rebuild the foundation of draw in Broadway Bridge. Approved April 15, 1874.

16. City of Boston, for leave to build Eastern-Avenue Bridge across Fort-Point Channel. Approved April 15, 1874.
17. Fitchburg Railroad Company, for leave to drive piles to support a railroad track scale in its bridge over Charles River. Approved April 22, 1874.
18. The Philadelphia & Reading Coal and Iron Company, for leave to extend its wharf in New Bedford Harbor. Approved April 22, 1874.
19. W. S. Fretch & Company, for leave to deposit dredged material in Salem Harbor. Approved April 29, 1874.
20. F. H. Moulton, for leave to construct a pile-pier in Salem Harbor. Approved May 6, 1874.
21. Alexander Gayland, for leave to build a wharf in Provincetown Harbor. Approved May 6, 1874.
22. City of Boston, for leave to extend the Northerly-Guard Pier on the North Ferry, East Boston. Approved May 13, 1874.
23. Swett & Company, for leave to extend their wharf in Gloucester Harbor. Approved May 20, 1874.
24. City of Boston, for leave to modify the foundation-pier for the draw of Eastern-Avenue Bridge. Approved May 20, 1874.
25. George Bancroft, for leave to construct a bulkhead and wharf in Charles River, Cambridge. Approved May 27, 1874.
26. Allen Reed, for leave to construct a pile-wharf in Provincetown Harbor. Approved June 3, 1874.
27. John K. Hodgdon, for leave to extend his wharf in Chelsea Creek. Approved June 3, 1874.
28. Samuel Knowles, for leave to build a wharf in Provincetown Harbor. Approved June 10, 1874.
29. Dennis & Ayer, for leave to extend their wharf in Gloucester Harbor. Approved June, 1874.
30. Oriental Coal Oil Company, for leave to extend their wharf in Mystic River. Approved June 26, 1874.
31. Walen & Allen, for leave to extend their wharf in Gloucester Harbor. Approved July 3, 1874.
32. Leighton & Company, for leave to extend their wharf in Gloucester Harbor. Approved July 3, 1874.

33. John E. Cassidy, for leave to build a sea-wall in Charles River, Watertown. Approved July 8, 1874.
34. John Pew, for leave to extend his wharf in Gloucester Harbor. Approved July 8, 1874.
35. James A. Woodbury, Solomon A. Woods and Frederick Pope, for leave to fill flats in Charles River, Cambridge, between West Boston and Cragie bridges. Approved July 8, 1874.
36. Pool & Cunningham, for leave to extend their wharf in Gloucester Harbor. Approved July 15, 1874.
37. Boston & Albany Railroad Company, for leave to build docks on its flats in South Boston. Approved July 24, 1874.
38. Benjamin Lancy, for leave to extend his wharf in Provincetown Harbor. Approved August 12, 1874.
39. Choate Burnham, for leave to build sea-walls in Dorchester Bay. Approved August 12, 1874.
40. Boston Gas Light Company, for leave to dredge in Neponset River. Approved August 19, 1874.
41. Fall River Iron-Works Company, for leave to extend its wharves in Fall River. Approved August 26, 1874.
42. Old Colony Railroad Company, for leave to build a bridge over Taunton River, between Fall River and Somerset. Approved August 26, 1874.
43. Boston & Lowell Railroad Corporation, for leave to widen its bridge over Charles River, and building a new draw in its freight-bridge. Approved September 16, 1874.
44. Edmund Durgin, for leave to dredge and fill flats in South Bay. Approved September 30, 1874.
45. City of Boston, for leave to extend Swett Street across South Bay. Approved September 30, 1874.
46. J. R. Bassett, for leave to build a wharf in Charles River, Cambridge. Approved September 30, 1874.
47. Henry L. Batchelder, for leave to extend his wharf in Fort-Point Channel. Approved September 30, 1874.
48. H. Barker & Co., for leave to build a sea-wall in Charles River, Newton. Approved October 8, 1874.

49. Josiah Quincy, for leave to dredge a channel in Quincy Bay. Approved October 29, 1874.
50. Joseph Friend, for leave to extend his wharf in Gloucester Harbor. Approved December 2, 1874.
51. John W. Wheeler, for leave to build a wharf in Goose or Granite Cove, Gloucester. Approved December 9, 1874.
52. Nathaniel Parsons, for leave to build a wharf in Goose or Granite Cove, Gloucester. Approved December 9, 1874.
53. Boston, Revere Beach & Lynn Railroad Company, for leave to construct a bridge over Sales Creek, Revere. Approved December 16, 1874.
54. City of Boston, for leave to rebuild the draw-pier in Broadway Bridge, over Fort-Point Channel. Approved December 16, 1874.
55. David Conwell, for leave to extend his wharf in Provincetown. Approved December 23, 1874.
56. John F. Wonson & Co., for leave to extend their wharf in Gloucester. Approved December 30, 1874.

Legislative Committee Hearings.

1874.

Feb. 26. On the petition of the Mayor of Chelsea, for authority to establish bathing-houses.

26. W. H. Brooks, for leave to extend his wharf in Chelsea.

Mar. 4. Mayor of Cambridge, for authority to build a bridge across Charles River, from Cambridge to some point on Beacon Street.

5. Mayor of Cambridge, for authority to lay out an Avenue from Brattle Street, Cambridge, to Market Street (Ward 19), Boston.

5. James A. Woodbury and others, for incorporation of the Cambridge Improvement Company.

10. Samuel Knowles, for leave to build a wharf in Provincetown.

10. Boston, Revere Beach & Lynn Railroad Company, for leave to establish a Ferry between Boston and East Boston.

Mar. 10. Harvey Scudder, for leave to build a wharf in Barnstable.

10. George Dickerman, for leave to build a wharf in in Mattapoisett.

17. Mayor of Cambridge, for authority to build a bridge across Charles River.

17. H. W. Wilson, J. F. Paul and Edward Atkinson and others, for legislation to improve South Bay.

HEARINGS BEFORE THE BOARD.

One hearing on the petition of Jonathan Seavey, in relation to detention of his vessel in the draw of the Boston & Lowell Railroad bridge across Charles River.

One hearing on the petition of the Old Colony Railroad Company, for leave to drive piles along its frontage in Fort-Point Channel.

Three hearings on the petition of Cook, Jordan & Morse, for leave to build wharves in Mill Creek, Neponset River.

One hearing on the petition of Charles A. Ropes, for leave to extend his wharf in Salem.

Three hearings on the petition of R. Murphy, for leave to build a boat-house on piles, north side of Dover-Street bridge.

One hearing on the petition of the Boston Boat Club, for leave to place a boat-house on Charles River at West Boston Bridge.

Three hearings in regard to Eastern-Avenue Bridge across Fort-Point Channel.

Three hearings in regard to a change in the harbor line, between the wharf of Leighton & Co. and the wharf of John Pew & Son, Gloucester Harbor.

Three hearings in regard to bridge built by the Eastern Railroad Company across Prison-Point Bay.

One hearing on the petition of the Philadelphia & Reading Coal and Iron Company, for leave to extend its wharf in New Bedford.

Two hearings with Street Commissioners of the city of Boston, in regard to the extension of Swett Street across South Bay.

Six hearings on the petition of James A. Woodbury, S.

A. Woods and Frederick Pope, for leave to fill flats in Cambridge, between West Boston and Cragie bridges.

Two hearings on the petition of the New Bedford Railroad Company, for leave to fill flats in New Bedford.

Two hearings with Boston & Lowell Railroad Company, in regard to the building of a new draw in its freight-bridge across Charles River.

One hearing on the petition of the Oriental Coal Oil Company, for leave to extend its wharf in Mystic River.

One hearing on the petition of Leighton & Co., for leave to extend their wharf in Gloucester Harbor.

Two hearings on the petition of the Mayor of Cambridge, in regard to the floats on the Boston pier of Cragie Bridge, kept by Cyrus Bruce.

One hearing on the petition of the Old Colony Railroad Company, in regard to a change in the location of its bridge across Taunton River, between the city of Fall River and the town of Somerset.

One hearing with the railroad commissioners, in regard to the proposed bridge across Taunton River, built by the Old Colony Railroad Company.

Four hearings on the petition of Nathaniel Parsons and J. W. Wheeler, for leave to build wharves in Goose or Granite Cove, Gloucester.

One hearing with the Mayors of Cambridge and Somerville, in regard to filling flats in Miller's River, near Boston & Lowell Railroad.

Two hearings on the petition of Winslow Stewart and Co. and others, in regard to filling done by the Boston & Lowell Railroad Company in Mystic River.

Three hearings on the petition of Edmund Durgin, for leave to dredge and fill flats in South Bay.

One hearing on the petition of Henry L. Batchelder, for leave to extend his wharf in Fort-Point Channel.

One hearing on the petition of Roland S. Hart, in relation to illegal filling done by the Boston Land Company in Revere.

One hearing on the petition of Atkins Nickerson and others, of Provincetown, in regard to rights of shore and wharf owners in Provincetown Harbor.

One hearing on the petition of Jenness & Bartlett, in relation to obstructions in the draw-way in bridge across Merrimac River, between Haverhill and Bradford.

Two hearings on the petition of David G. Allen, for leave to extend his wharf in Gloucester to the commissioners' line.

Plans and Surveys.

Preparation of Plans for Annual Reports.

Two plans, showing old and proposed new harbor lines in South Bay.

One plan, showing areas of South Boston Flats to be exchanged between the Commonwealth and the Boston & Albany Railroad Company.

Survey of flats in front of city institutions, for the purpose of dumping material dredged from Upper Middle Bar.

Survey in Charles River, for the purpose of wharf extension by H. Cousen, near Brookline Bridge.

Survey in Salem on account of wharf extension by Charles A. Ropes.

One plan, showing the territory of the Boston & Lowell Railroad Company in Miller's River.

Survey on account of establishing a harbor line in Mystic River, south channel.

Survey in New Bedford on account of wharf extension by the Philadelphia and Reading Coal and Iron Company.

Survey in Gloucester, for the purpose of changing the harbor lines.

Survey in Salem for the purpose of determining dumping ground for dredged material.

Survey in Charles River between West Boston and Cragie bridges, on account of the Cambridge Improvement Company, and two plans made of same.

Survey to establish the harbor line on Commercial Point and Mill Creek.

One plan to accompany report of engineer, for the purpose of wharf extension in Mystic River.

Survey and inspection of Hick's Bridge over Westport River.

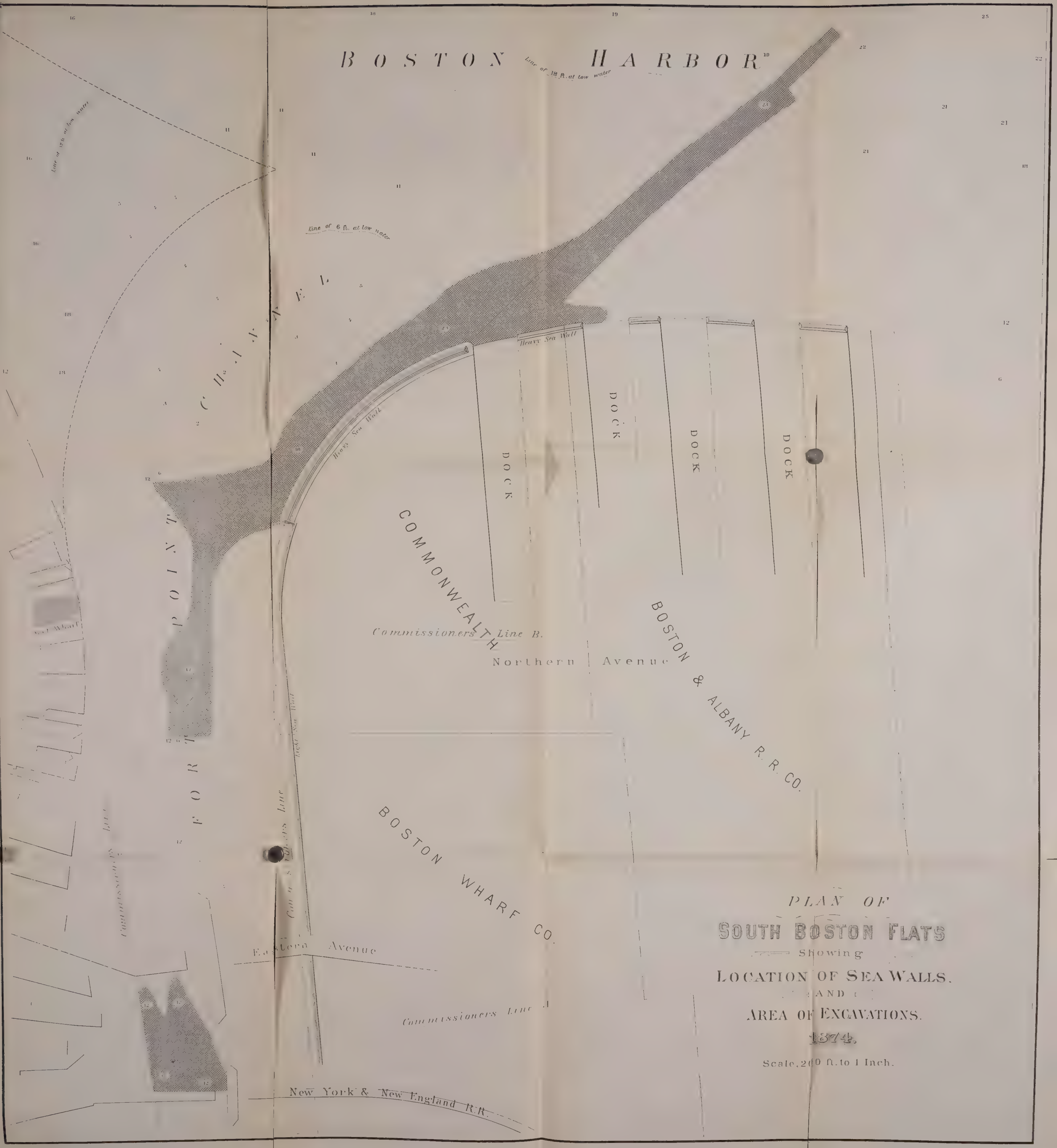
Survey in Gloucester, for the purpose of wharf extensions by Nathaniel Parsons and J. W. Wheeler.

Survey of Junction Shoal, Boston Harbor, and plan made of same.

The above record indicates an encouraging interest and activity in enterprises of harbor and coast improvement. Notwithstanding the depressed condition of business and money matters, the number of licenses applied for and granted by the Board, and the inquiries for information which have been made, compare favorably with that of former years.

Fifty-six plans for various structures and improvements within the tide-waters of the Commonwealth, have been approved during the last year.

JOSIAH QUINCY,
F. W. LINCOLN,
J. N. MARSHALL,
W. T. GRAMMER,
ALBERT MASON,
Board of Harbor Commissioners.



PLAN OF

SOUTH BOSTON FLATS

Showing

LOCATION OF SEA WALLS.

AND

AREA OF EXCAVATIONS.

1874.

Scale, 200 ft. to 1 Inch.

APPENDIX.

APPENDIX.

[A.]

IMPROVEMENT OF SOUTH BOSTON FLATS.

Report of Engineer in Charge, December 31, 1874.

Work was begun under the contract of Messrs. Clapp and Ballou and the Rockport Granite Company, in October, 1873, by dredging in the location for the heavy sea-wall, the material being deposited for filling the flats of the Commonwealth, to be inclosed by the wall. This work progressed, with some slight interruption, up to September, 1874, when the whole area proposed to be filled had been filled as high as it was practicable to do, by dumping from scows at high water. The contractors have been now, for several months, experimenting upon some apparatus for raising the mud to a higher level, but so far without success; so that the dredging has ceased for some time, after having removed about 160,000 cubic yards. The price to be paid, under the contract for this work, was thirty-nine cents per superficial foot for the ground filled to grade sixteen. The average depth was found to be such as to make this price equivalent to about fifty-eight cents per cubic yard of material.

But as the work hitherto done, by dumping from scows, is much less costly to the contractor, per cubic yard, than the portion to be done hereafter, where the material must be raised higher that the tide will float it, I have not felt justified in estimating the value of the work actually done as over forty-five cents per yard, and my monthly reports for partial payments have accordingly been carried out at the latter rate. The whole amount of filling yet remaining to be done upon the section in progress, reserving a space for a dock, will be about 435,700 cubic yards.

Soon after the beginning of the dredging and filling; viz., in November, 1873, work was begun upon the pile foundation for the light wall along Fort-Point Channel. This was prosecuted, as the weather permitted, during the winter, and the masonry was begun in the latter part of March, 1874, and continued till the completion of the work, from the boundary of the Boston Wharf Company's flats, for six hundred and forty-one feet, being nearly to the point fixed upon for the beginning of the heavy wall. This structure is now essentially finished, and will, in my opinion, compare favorably with the best work of its class in the country.

In April, 1874, work was begun in depositing rubble for the heavy wall, in the trench which had been dredged for the purpose, and progressed till the present time. We now have the base of this structure nearly finished, from the end of the light wall to the point where the first dock is proposed, say 765 feet in length, containing some 12,000 cubic yards of material. Most of this has already been levelled up by divers, to receive the cut granite. Great care has been taken to insure the compactness of this material. It has received the repeated inspection of divers employed by the State, as well as the occasional personal inspection of a more intelligent kind, through Mr. Joseph O. Osgood, in whose fidelity and thoroughness I have great confidence.

During the month of September, 1864, the work of laying the cut stone for the heavy wall was begun, and is still in progress, when the weather allows.

Some delay was occasioned in beginning this work, arising from its novelty, and the difficulty in having the specifications well understood at the quarries, where the stone should be dressed to the proper shape and dimensions, for no opportunity is had for such dressing after their arrival. The material is brought from Cape Ann by sloops, and laid in places as unloaded by divers, who adjust each stone in its place, while lowered to them by steam-derricks on the sloop's deck. About 1,105 yards of this masonry have been laid, mostly in the lower courses, all the work being still several feet below low water.

Now that the workmen have become familiar with the matter, the progress may be expected to be more rapid, whenever the weather allows; and though it may not be completed as soon as agreed, viz., August 1, 1875, it will perhaps be finished in season to meet commercial demands for its use. The work of completing the heavy wall up to the boundary between the flats of the Commonwealth and those sold to the Boston and Albany Railroad Company, with the filling contemplated, reserving space for one dock, will cost, at rates of present contract, about as shown in the estimate given below, reckoning from the beginning.

Estimate of whole cost of improvement of section of flats betweeen Fort-Point Channel and the flats of the Boston & Albany R. R. Co., exclusive of the dock, for which space is reserved.

885,000 square feet filling, at 39 cents,	$345,150 00
715 lin. feet light wall, at $39,	27,885 00
815 lin. feet heavy wall, at $236,	192,340 00
140 lin. feet heavy wall beyond dock, at $248,	34,720 00
Total cost when finished,	$600,095 00
Value of work to date,	$155,000 00
Value of work to be done,	$445,095 00

Respectfully submitted by
Your obedient servant,

EDWARD S. PHILBRICK.

[B.]

United States Engineers' Office,
Boston, Mass., January 11, 1875.

Hon. Josiah Quincy, *Chairman, Board of Harbor Commissioners, Boston, Mass.*

Sir,—I have the pleasure of furnishing, in compliance with the request contained in your letter of the 31st ultimo, a copy of my report to the Chief of Engineers, on the several works under my charge, for the improvement of harbors and rivers in the State of Massachusetts, for the six months ending December 31, 1874.

Very respectfully,
Your obedient servant,

GEO. THOM,
Lieut.-Col. of Engineers, Bvt. Brig.-Gen. U. S. A.

I. Improvement of Boston Harbor, Massachusetts.

The several works projected and in progress for the improvement and preservation of this harbor, consist of the following, viz.:—

1. The sea-wall for the protection and preservation of Point Allerton;
2. The sea-wall for the protection and preservation of Great Brewster Island;
3. The sea-walls for the protection and preservation of Lovell's Island;
4. The sea-wall for the protection and preservation of Gallop's Island;
5. The sea-wall for the protection and preservation of the North Head of Long Island;
6. The sea-wall for the protection and preservation of Deer Island;
7. Straightening, widening and deepening the main ship-channel in the Narrows;
   (a.) At the west end of Great Brewster Bar;
   (b.) At the south-east point of Lovell's Island; and
   (c.) At the south-west point of Lovell's Island.
8. Widening and deepening the channel through the Upper Middle Bar;
9. Removal of Nash's Rock;
10. Completing the removal of Kelly's Rock;

11. Removal of a sunken ledge situated in "The Narrows," between George's Island and Great Brewster Spit;
12. Removal of State and Palmyra rocks, on the southern spurs of the Lower Middle;
13. Surveys of sunken rocks.

1. *Sea-wall on Point Allerton.*—Work was commenced upon this sea-wall, in September, 1870, and was completed in May, 1874, having been built, for the most part, under four separate contracts with Mr. James M. Andrews, of Biddeford, Me., made respectively May 24, 1870, July 26, 1871, August 24, 1872, and May 8, 1873. The last contract provided for completing this sea-wall at the same prices as in previous contracts, viz.:—

1. Granite wall (including granite facing and coping concrete foundation and back-filling), at $77.90 per linear foot.

2. Concrete for additional foundation, if required, in excess of that called for by the drawings and specifications, at $11 per cubic yard;

3. Excavation for foundation, at $1 per cubic yard;

4. Back-filling of each, at fifty cents per cubic yard;

5. Paving (including paving-stones and cobble-stones, shingle and gravel for bedding), at $6.40 per superficial yard.

The total quantity of work done under this contract in completion of the sea-wall, was as follows, viz.:—

277.2 linear feet of granite wall;
1,189$\frac{1}{3}$ cubic yards of excavation for the foundation;
5,359$\frac{1}{2}$ cubic yards of earth back-filling;
1,905 superficial yards of granite paving.

In addition to the above contract work, there have been built since July 1, 1873, for the protection of the concrete foundation of this sea-wall, where most exposed to injury by storms and currents, 1,005 linear feet of granite apron, and eight jetties, in which have been placed 1,598.94 tons of granite grout. This apron has an average width of about ten feet, is from two to three feet in height, and extends all along the fourth, fifth, sixth, seventh and eighth faces, counting from the east, and for about fifty feet along the first face, and along the western wing-wall, in order to protect its junction with the shore crest. The several jetties have a length of twenty-five to thirty feet, a width of about six to eight feet, and a height of two to three feet, and are placed five at the fourth, fifth, sixth, seventh and eighth angles, two from the middle of the first and seventh faces, and one at the easterly wing-wall. The total length of this sea-wall, as completed, is 1,202½ feet.

2. *Sea-wall on Great Brewster Island.*—This wall, 2,800 feet in length, was built for the protection of the north and south heads of the island, and fully answers the purpose intended. It was commenced in 1849, and was continued through the year 1850, when work upon it was suspended. Since then it has been continued from time to time as appropriations have been made for it. It is now in good condition, not requiring any repairs.

3. *Sea-walls on Lovell's Island.*—There are two sea-walls on this island, one of which was built thirty years ago, for the protection of its north head, and the other in 1867 and 1868, for the protection of the south-east bluff for a length of about 800 feet. These sea-walls have been recently repaired and are now in good condition.

4. *Sea-wall on Gallop's Island.*—This sea-wall is 1,745 feet in length. Work upon it was commenced in the year 1868, and was completed in September, 1871. The violent storms and currents to which this wall is exposed, have laid bare its concrete foundation to such a degree as to have rendered necessary, for its protection and preservation, a stone apron throughout nearly its whole length, with jetties projecting outwards from its faces. This work was commenced in August, 1873, and completed in April, 1874. The apron extends along the base of this wall for a length of 1,655 feet, being on the most exposed faces of the wall, ten feet in width. Eight jetties have been built at and near the angles of the wall, of which five are of split granite, bedded in part in concrete, laid in trenches, and surrounded with a concrete apron, each being eighteen feet in length and five feet in width. The quantity of stone used in this work was about 1,450 tons.

5. *Sea-wall on the North Head of Long Island.*—Work was commenced upon this sea-wall in August, 1870, and has been continued for the most part under contracts with Mr. James Andrews, of Biddeford, Me., made respectively May 24, 1870, July 26, 1871, August 23, 1872, and May 8, 1873; the last of which provided for completing this sea-wall at the same prices as in previous contracts, viz.:—

1. Granite wall (including granite facing and coping, concrete foundation and backing), at $58.19 per linear foot;

2. Concrete for additional foundation, if required, in excess of

that called for by the drawings and specifications, at $10.25 per cubic yard;

3. Excavation for the foundation, at $1 per cubic yard;

4. Back-filling, at fifty cents per cubic yard;

5. Paving (including paving-stones and cobble-stones, shingle and gravel for bedding), at $5 per superficial yard.

The contractor commenced work under his last contract, in May, 1873, and continued it until its completion, in July, 1874. The work done under the contract of May 8, 1873, was as follows, viz.:

$541\frac{715}{1000}$ linear feet of granite wall;
$1,335\frac{77}{100}$ cubic yards of excavation for the foundation;
$5,617\frac{5}{10}$ cubic yards of earth back-filling;
$3,391\frac{935}{1000}$ superficial yards of granite paving.

The length of this sea-wall is 2,080 feet.

In addition to the above contract work, there have been built since about the first of April, 1874, for the protection of the concrete foundation of this sea-wall where most exposed to injury by storms and currents, about 975 linear feet of stone apron, and ten jetties. This work was completed early in August, 1874.

6. *Sea-walls on Deer Island.*—The three sea-walls on this island were built about thirty-five years ago, for the protection and preservation of the north, middle and south heads, and were respectively 1,740, 840, and 420 feet in length. The injury which these walls had sustained from the violence of the storms was such as to necessitate the rebuilding of them to a great extent. This was commenced in 1865, and completed in 1869. Repairs have recently been made where necessary, so that the walls are now in good condition.

7. *Straightening, Widening and Deepening the main Ship-channel at "The Narrows."*—This work consists in the removal of portions of Brewster Spit and Lovell's Island, so as to obtain a depth of twenty-three feet at mean low water, for a width of 600 feet, with proper slopes up the eighteen-feet curve. Work was commenced on Lovell's Island in 1867, and continued during that and the two following years, until suspended for want of funds. The officer then in charge of this work reported that by these operations the whole south-west point of this island was cut off for a width of 260 feet from the top of the bank in a regular slope to a depth of twenty-three feet at mean low water; and that the channel at that

point had been widened at the depth of the eighteen-feet curve from its former width of 365 feet to 625 feet.

With a view to ascertaining the condition of the channel in "The Narrows" and its vicinity, and what changes, if any, had taken place therein since the completion of the improvements there, including the enlargement of the channel at Lovell's Island, a re-survey of that locality was made, under my direction, in July and August, 1872. This survey showed that the channel at the south-west point of Lovell's Island had not changed to any considerable extent since the dredging operations were closed in 1869; that the eighteen-feet curve was very nearly the same as it was then; and that the shore above low-water line had acquired a more natural slope of eight feet horizontal to one foot rise by the receding inland of the high-water line; also, that the flats off the south-east point of Lovell's Island had advanced so much toward the main channel as to materially impede and endanger navigation. It also showed that the extreme westerly end of Brewster Spit had continued to extend in a westerly or south-westerly direction, the point on low-water line being 120 feet further out than in 1860, and the present eighteen-feet curve 168 feet from that of 1860.

The estimated cost of the improvement of "The Narrows," by the excavation from Lovell's Island to a depth of twenty-three feet at mean low water for a width of 600 feet, with proper slopes inward, and by excavating Brewster's Spit, as contemplated, is as follows, viz.:—

1. Brewster's Spit, 60,000 cubic yards, dredging on westerly extremity of the Spit, at forty cents,	$24,000 00
2. Lovell's Island, 40,000 cubic yards dredging on south-east point, at forty cents,	16,000 00
3. Lovell's Island, 40,000 cubic yards dredging on south-west point, at forty cents,	16,000 00
Total,	$56,000 00

The improvements projected at the west end of Great Brewster Bar, and at the south-east point of Lovell's Island, have been taken in hand, under the appropriation for this harbor, made by Act of June 23, 1874, for which the following contracts have been made, after advertising for proposals, viz.:—

1. With the New-England Dredging Company, of Boston, for the required dredging at the west end of Great Brewster Bar, at thirty-nine cents per cubic yard,—to be completed June 15, 1875; and

2. With Messrs. Boynton Brothers, of Boston, for the dredging

required on the south-east point of Lovell's Island, at thirty-eight cents per cubic yard,—to be completed June 30, 1875.

The New-England Dredging Company has made very unsatisfactory progress under its contract, having suspended work for the season in the latter part of October, after having done but 4,852 cubic yards of dredging; whilst Messrs. Boynton Brothers have accomplished 11,905 cubic yards of dredging, from their continuing work until the middle of December.

8. *Widening and Deepening the Channel through the "Upper Middle Bar."*—The improvement projected for this bar consists in opening through it a channel to a width of 600 feet, and a depth of twenty-three feet at mean low water, the average length of the "cuts" being 2,200 feet, with an excavation of one to seven feet.

The work done up to the 1st of January, 1874, amounted to the excavation of 46,425 cubic yards, by which an entire "cut" was completed to a width of forty feet, and a length of 8,000 feet; and a second "cut" completed for a length of 1,040 feet, and to a depth of twenty-three feet at mean low water, including the removal of a very large bowlder (discovered in the channel in 1872), having but 16½ feet of water on it at mean low water.

On the 27th of January, 1874, proposals were invited for 75,000 cubic yards, more or less, of dredging and rock excavation in continuation of this improvement, and a contract was made for the work on the 5th of March, 1874, with the Atlantic Dredging Company, of Brooklyn, N.Y., which was the lowest of four bidders, at sixty-four cents per cubic yard for excavation of ledge, and bowlders exceeding six tons in weight. Operations were commenced under this contract early in April, 1874, and have since been continued, 32,951 cubic yards of dredging having been done up to the 1st of January, 1875, leaving about 42,000 cubic yards still to be done in completion of this contract.

Under the appropriation made by Act of June 23, 1874, for continuing the improvement of this harbor, a contract was made September 1, 1874, with the Harbor Improvement Company, of Boston, for 42,000 to 55,000 cubic yards of additional dredging on this bar, at eighty-five cents per cubic yard, to be completed on or before the 15th of August, 1875. Work was commenced under this contract on the 3d of October, and continued until the middle of December, when it was suspended for the winter, 7,011 cubic yards of dredging having been done under this contract.

By the dredging thus far done on this bar, the projected channel has been opened to a width of about 175 feet, for a depth of not less than twenty-three feet at mean low water, with a probability of its completion at an early date, for its projected width of 600 feet.

9. *Removal of Nash's Rock.*—Nash's Rock (so called) is a shoal lying in the outer entrance to Boston Harbor, about one-third of the way over from Brewster's Spit to Point Allerton. This shoal was surveyed under my instructions in September and October, 1873, and a special report thereon, accompanied by drawings, was submitted to the Department on the 24th of March, 1874. From information acquired by this survey, it is seen that the only portion of this shoal which it would be advisable and practicable to improve, is that having less than twenty-one feet of water over it at mean low water, which portion has an area of 637½ superficial yards, and would require, in order to obtain a depth of twenty-one feet, the excavation and removal of about two hundred cubic yards of bowlders, shingle, etc., at an estimated cost of $5,000; whereas, to remove the whole shoal to a depth of twenty-three feet below the plane of mean low water, would require the additional excavation of over 16,000 cubic yards of similar material over an area of $9\frac{1}{16}$ acres, the cost of which would be greatly disproportionate to the benefit that would result therefrom.

10. *Completing the removal of Kelly's Rock.*—This rock lies in the main channel, distant about 700 yards, in a direction south-east by south from the Bug Light (at "The Narrows"), and in the line of entrance-buoy No. 1 and Bug Light. In the autumn of 1869, operations were continued, up to the end of December, 1870. These operations were resumed in June, 1873, and were continued until the 25th of July following, during which time 118 tons of rock were removed. An accurate survey, since made, shows that there is still an area of about 320 superficial yards of this ledge which has less than the projected depth, on the shoalest parts of which there are but 21.2 feet of water at mean low water. In order to obtain the full depth of 23 feet at mean low water, the additional removal of not less than 80 cubic yards will be required, the estimated cost of which is $5,000.

It is contemplated to have this work completed under the appropriation made for this harbor by Act of June 23, 1874.

Proposals have been twice invited for it, but none have been received which are deemed satisfactory.

11. *Removal of Sunken Ledge, situated in "The Narrows," between George's Island and Great Brewster's Spit.*—This ledge was discovered in September, 1872, in a re-survey of "The Narrows,"

made under my direction. It was situated near the middle of the main ship channel, directly in the track of all large vessels, and particularly of the European steamers, and was distant 317 yards in a direction west by south from Bug Light. It had but $18\frac{9}{10}$ feet of water upon it at mean low water, and was therefore a dangerous obstacle to navigation. Under the appropriation of June 23, 1874, a contract was made August 31, 1874, with Mr. William H. Lloyd, of Boston, for the removal of this ledge, to a depth of 23 feet at mean low water, (altogether $16\frac{1}{8}$ cubic yards), for the sum of $400, which he completed early in September last.

12. *Removal of State and Palmyra Rocks.* A survey was made of these rocks, under my direction, and in accordance with my project submitted to the department under date of April 2, 1872, of which a special report and drawings were transmitted to the department on the 25th of May, 1874. By this survey it was ascertained that State Rock and Palmyra Rock, of the position and character of which but little previously had been known, are situated very near each other, and most probably are outcroppings of the same ledge, forming spurs on the southern side of the Lower Middle Bar.

To effect the improvement proposed, required, altogether, the removal of about 62 cubic yards of rock, for effecting which, a contract was made August 31, 1874, with Mr. William H. Lloyd, of Boston, who was the lowest of two bidders, at $1,500—the job to be completed on or before the 30th of June, 1875. This work has already been for the most part completed, with the probability of its entire completion within the time called for by the contract.

13. *Survey of sunken rocks.* The discovery in September, 1872, of an unknown rock in the main ship channel at "The Narrows," in the vicinity of Lower Corwin and Kelly's Rocks, created a doubt as to the existence of other unknown rocks in that vicinity. In July, 1873, a careful examination of this channel, was made by dragging for several days between Corwin's Rock and the north-west point of George's Island, and by taking a large number of range and random soundings east of Kelly's Rock, but without discovering any new rocks having less than 23 feet of water over them, at mean low water.

A similar examination has also been made over the shoals east of Great and Little Faun, in Broad Sound, in order to ascertain the locality of certain dangerous rocks, the existence of which has been reported; but after a careful and extended search over an area of 1,000 by 500 feet, which was found to be covered with numerous bowlders of various sizes, no rocks were found having less than 13 feet of water over them at mean low water.

The navigation of the north channel is almost always dangerous, and is especially so at low water. To remove all the rock that would be necessary, should the improvement of the navigation of this place be undertaken, would cost much more than would be warranted by the benefit thereby gained.

The following is a recapitulation of the estimated cost of the several works projected for the further improvement of Boston Harbor, viz.:

1. Additional work to be done for straightening, widening and deepening, the main ship channel at "The Narrows," including outstanding obligations on existing contracts, say		$46,000 00
2. Completing channel through the "Upper Middle,"—		
a. 42,000 cubic yards dredging, at 64 cents, as per contract of March 5, 1874, including percentage retained on work already done,	$32,368 00	
b. 45,000 cubic yards dredging, at 85 cents, as per contract of September 1, 1874, including percentage retained on work already done,	40,900 00	
c. 105,000 cubic yards dredging, not yet provided for, at 85 cents,	89,250 00	
		162,518 00
3. Removal of "Nash's Shoal,"		5,000 00
4. Completing removal of Kelly's Rock,		5,000 00
5. Removal of State and Palmyra Rocks, as contracted for,		1,500 00
Adding for contingencies, say		17,276 06
Total,		$237,294 06
Amount available January 1, 1875,		117,294 06
Additional amount required for completing all projected improvements,		$120,000 00

II.—Improvement of Merrimac River, including the Harbor of Newburyport, Massachusetts.

The following appropriations have been made for the improvement of Merrimac River, Mass., viz.:

By Act of July 11, 1870, for improvement of Merrimac River, Mass.,	$25,000 00
By Act of March 3, 1871, for improvement of Merrimac River, above Haverhill, Mass.,	25,000 00
By Act of June 10, 1872, for improvement of Merrimac River, above Haverhill, Mass.,	25,000 00
By Act of March 3, 1873, for improvement of Merrimac River, Mass.,	25,000 00
By Act of June 23, 1874, for improvement of Merrimac River, Mass.,	10,000 00
Total,	$110,000 00

Up to the first of July, 1874, the work was done as follows, viz.:

1. The main (south) Gangway Rock, in Newburyport Harbor, broken up and removed in 1870, to a depth of 9½ feet at mean low water, and a commencement made on North Gangway Rock.

2. The wreck of the schooner Globe removed in 1870.

3. 2,731 cubic yards of clay, bowlders, etc., excavated and removed from the channel of the Lower Falls, above Haverhill, by which the work on these falls was about half completed.

4. The following contracts had also been made under the appropriations of June 10, 1872, and March 3, 1873, with Mr. Augustus R. Wright, of Geneva, N. Y., the lowest bidder, for improving the channel in the Lower Falls, Hazeltine Rapids, and the Upper Falls, viz.:

a. By contract, dated September 9, 1872, for 4,400 cubic yards, more or less, of excavation in the Lower Falls and Hazeltine Rapids, at $4.95 per cubic yard, under which contract 156 cubic yards of dredging was done in 1873; and,

b. By contract, dated May 30, 1873, for 5,000 cubic yards, more or less, of excavation in the Upper Falls, at $4.50 per cubic yard; under which contract 3,755 cubic yards of dredging was done in the autumn of 1873. Operations were resumed by Mr. Wright, at the Lower Falls, on the 29th of June, 1874, under his contract of September 9, 1872, and were there continued by him until the 21st of July following, resulting in 1,950.7 cubic yards of dredging, after which he resumed work at the Upper Falls, under his contract of May 30, 1873, which he continued, without interruption, until its completion, in September, 1874, resulting in 3,146.2 cubic yards of dredging,—making altogether 6,901.28 cubic yards done at the Upper Falls. In the latter part of September, after having completed the work at the Upper Falls to the extent proposed, Mr. Wright resumed work at the Lower Falls and at Hazeltine Rapids, which continued until the middle of December, resulting in the completion of all the projected dredging, viz.: 1,619.5 cubic yards; and of 50 cubic yards of ledge excavation, under his contract of September 9, 1872. To complete this work to the full extent contemplated, there remains only the removal of some of the highest points of the ledge at the Lower Falls, for which the funds now available are sufficient.

With this improvement, the channel at Hazeltine Rapids, and at the Lower and Upper Falls, will be navigable for a depth of four feet, in all stages of the river, except in an unusually low stage, which results from shutting off the water, at the Lawrence mills, on Sundays and at night, combined with the low water of spring tides, an event which would seldom interfere with its navigation. The additional improvements, and the estimated cost of same, projected for this river, at Newburyport, and thence up to Haverhill, Mass., are as follows, viz.:

1.—Newburyport Harbor at the Mouth of Merrimac River.

a. Complete removal of North Gangway Rock, 700 cubic yards, at $20,	$14,000 00
b. Removing "The Boilers," near the city wharves,	6,000 00
Adding for contingencies, say	2,000 00
Total,	$22,000 00

2.—River between Newburyport and Haverhill, Massachusetts.

a. Removal of Gangway Rock, 14 cubic yards at $20,	$280 00
b. Removal of two rocks, above Deer Island Bridge, 108 cubic yards, at $20,	2,160 00
c. Removal of rocks at Rocks Bridge,	1,000 00
d. Removal of Little Currier Rock, 2 cubic yards,	25 00
e. Dredging at Currier Shoal, 6,500 cubic yards at 75 cts.,	4,875 00
f. Dike at Silby's Head, 350 feet, at $25,	8,750 00
Adding for contingencies, say	1,910 00
Total,	$19,000 00
Total amount required for completing all the projected improvements, as above, being the amount which Congress has been asked to appropriate therefor, is	$41,000 00

III.—IMPROVEMENT OF GLOUCESTER HARBOR, MASSACHUSETTS.

By an Act of Congress, approved June 10, 1872, the sum of $10,000 was appropriated for the removal of sunken rocks in this harbor; and with it they have all been removed to the extent contemplated, being as follows, viz.:

1. Clam Rock, removed from a depth of 1 foot to that of 9⅓ feet below the plane of mean low water, the level of the surrounding bottom.

2. Pinnacle Rocks, removed from 8½ feet above, down to the level of the surrounding bottom, which has a depth of 16½ feet below the plane of mean low water.

3. Rocks off J. Friend's wharf, removed down to the level of the surrounding bottom.

4. Rock off Pew's wharf was entirely removed to a depth of 5 feet below mean low water; and

5. The largest bowlders were removed from the rocky shoal known as "Babson's Ledge."

The unexpended balance of the appropriation is $686.84.

IV. IMPROVEMENT OF SALEM HARBOR, MASSACHUSETTS.

The following is an estimate of the cost of the work projected for the improvement of this harbor, viz.:

1. Excavating a channel 1,730 feet long, 300 feet wide, to a depth of 8 feet at mean low water (giving 17.3 feet at mean high water), from the entrance to South River outward to deep water, including contingencies, . .	$25,000 00
2. Constructing a sea-wall and a breakwater for the preservation and protection of Long Point, including contingencies, ...	23,000 00
Total	$48,000 00

For this work, the following appropriations have been made by Congress, viz.:

By Act of March 3, 1873, ...	$15,000 00
By Act of June 23, 1874, ...	10,000 00
Total, ...	$25,000 00

Under the appropriation of 1873, a contract was made with Mr. Augustus R. Wright, of Geneva, N.Y., for 31,496 cubic yards of dredging, at 44 cents per cubic yard, which he completed in March, 1874; whereby the channel at the entrance to South River was opened to a depth of 8 feet at mean low water, outward to deep water, for an average width of 160 feet.

Under the appropriation of 1874, a contract was made September 5, 1874, with Messrs. Curtis, Fobes, & Co., of Portland, Me., the lowest of four bidders, for completing all the projected dredging at this place—30,000 cubic yards, more or less,—at the following prices, to wit:

1. Stiff clay intermixed with bowlders, at 35 cents per cubic yard; and,

2. Soft mud, at 20 cents per cubic yard,—both as measured in the scows; the same to be completed on or before the 1st of May, 1875.

Work was commenced, under this contract, on the 9th of December, 1874, and was continued throughout the month; by which 9,916 cubic yards of dredging has been done.

The projected sea-wall and breakwater, for the preservation and protection of Long Point, as estimated, will cost $23,000, the amount which Congress has been asked to appropriate therefor.

V. IMPROVEMENT OF DUXBURY HARBOR, MASSACHUSETTS.

The following appropriations have been made for the improvement of this harbor, viz.:

By Act of Congress, approved June 10, 1872, . . .	$10,000 00
By Act of Congress, approved March 3, 1873, . . .	10,000 00
Total, ...	$20,000 00

This work consisted in the improvement of the South Channel, which extends from the "Cow Yard," so called, up in a north-westerly direction between Captain's Hill and Kingston Flats. This channel, where navigable, is about three miles long; and for a distance of two and a half miles, it had a width of not less than 200 feet, with about 11½ feet of water at mean low water (or about 21 feet at mean high water); whilst for the remaining distance it was narrow and crooked, having a width of not more than 80 feet, for a depth of 8 feet of water at mean low water. The appropriations made as above, have been applied to straightening and widening the upper portion of this channel, so as to have a width of about 200 feet for a depth of 8 feet at mean low water. This work was completed in May, 1874, under the two contracts heretofore reported.

VI. IMPROVEMENT OF PLYMOUTH HARBOR, MASSACHUSETTS.

The existence of this harbor depends upon the protection and preservation of Long Beach, which is a narrow strip of land, extending from the main land to the south-east of Plymouth out for about 2¾ miles in a north-westerly direction, terminating in a stone beacon. This beach is distant about one mile from the wharves of Plymouth, and affords to the harbor inside of it the only shelter it has from easterly storms. In late years, this beach has been washed away in some places and much weakened in others, to an extent seriously threatening the ruin of the harbor. For the protection and preservation of this beach various works have from time to time been built, until they have finally been attended with success. During the last five years, the aggregate sum of $30,500 has been appropriated for this harbor by Congress, including the sum of $5,000 appropriated by Act of June 23, 1874.

These appropriations have been applied to the construction of bulkheads, jetties and groins, and the planting of beach-grass, where most necessary, for protecting and strengthening this beach. These bulkheads and jetties are built either of stone or of frame-work filled with brush, and ballasted with stone; and the groins, of small stone intermixed with brush, and sometimes of brush alone. The bulkheads and jetties have accumulated a large quantity of sand, on which beach-grass has been planted throughout mostly its whole extent, thereby forming a high and serviceable backbone. But for the purpose of increasing its strength and permanency at its outer end, parallel groins have been run out perpendicularly to this bulkhead, on the seaward side, varying in length from 75 to 265 feet, whilst others have been placed inside of it, in a way to operate to the best advantage for the purpose in view.

On referring to my last annual report, it will be seen that during the fiscal year ending June 30, 1874, the following work had been done on this beach, viz. :—

Twenty-three groins of brush and stone, having a total length of about 3,000 feet, and ten groins of brush alone, having a total length of 534 feet, were constructed on the outer extremity of Long Beach. The brush and stone groins were made by placing brush flat on the surface of the beach, and piling upon it beach bowlders to a height of about eighteen inches. These groins are about five feet wide. The brush groins were made by digging a trench two feet by two feet, and placing brush in it upright and as close as practicable, the brush held by sand being thrown into the trench and well rammed down, and sometimes further protected by small bowlders placed in a row along the sides of the groin. The brush rises about two or three feet above the surface of the beach. These groins are located as follows: Eleven brush and stone groins and three brush groins on the outside of the breakwater, perpendicular to it, and in the first 800 feet from the beacon; ten brush and stone groins and six brush groins on the outside of the plank bulkhead, perpendicular to it, and along a distance of 300 feet, commencing at a point about 1,800 feet from the beacon; one brush and stone groin at the beacon, on the inside of the bulkhead, and perpendicular to it; one on the inside of, and nearly parallel to, the plank bulkhead, about 500 feet long, commencing about 400 feet from the beacon; and one brush groin fills an interval on the plank bulkhead, about 1,700 feet from the beacon. In constructing these groins, 1,583 tons of small bowlders were used.

Work was continued upon these groins under the appropriation of June 23, 1874, from the first of August until the latter part of November, 1874, when it was suspended for the winter. During the latter period, the following additional work has been done, viz. :—

Two thousand eight hundred and forty linear feet of stone and brush groins; 320 linear feet of brush groins built outside of the breakwater, and about 250 feet of stone and brush groins built inside of it; also a framework bulkhead filled with brush and stone, eleven feet in length, built about half way up the beach, in order to strengthen it where broken through by the storm of November, 1873. In these groins and bulkheads, 1,617 tons of small bowlders have been used.

Of the appropriation made for this work, by the Act of June 23, 1874, there remains an available balance, January 1, 1875, of	$1,445 21

For the further improvement and preservation of this harbor, the following sums will be required, viz :—

1. For completion of the work projected for the preservation of Long Beach, and for such repairs, planting of beach-grass, etc., as may be necessary, ...	$2,000 00
2. Should it be decided to improve the harbor by dredging, as described in my special report to the Department, dated February 14, 1874, it is therein estimated that the cost thereof will be	28,000 00
Total, ...	$30,000 00

VII. Improvement of Wellfleet Harbor, Massachusetts.

All the sunken rocks have been removed from this harbor at its entrance and above, to the extent contemplated and deemed necessary, including Channel Rock, Mayor's Rock, Bay Rock, Lobster and Lumpfish rocks.

VIII. Improvement of Provincetown Harbor, Massachusetts.

Under the several appropriations heretofore made for the preservation and improvement of this harbor, the following work had been done on the 1st of July, 1874, viz. :—

1. Bulkheads and jetties of various descriptions had been built from time to time along Beach Point for its preservation and protection, both by the United States government and by the local authorities.

2. A dike was built in 1868 and 1869 by the State of Massachusetts across the outlet of East Harbor Creek.

3. A dike was built in 1868 and 1869 by the United States government across East Harbor Creek, at the Wading Place, near High Head, about two miles above the outlet of the creek.

4. Wooden bulkheads and jetties had been built at different times for the protection and preservation of the beach on Long Point.

5. A stone bulkhead had been commenced for the protection and preservation of the outer end of Long Point, the lighthouse and the Three-Gun Battery.

6. A substantial dike (272 feet in length) was built in 1871–72 across the head of Lancey's Harbor, near Abel Hill.

7. Beach-grass planted on Beach Point, Long Point, Abel Hill, Cove Section and Oblique Section, and at the last two places brush had also been laid for their further protection.

8. The projected extension of the several jetties on Beach Point and State Dike had been completed; and

9. Accurate resurveys had been made (1871, 1872, 1873 and 1874) of Cove Section, Oblique Section, Beach Point and Long Point, together with elaborate soundings and current observations in the inner harbor.

On the first of July, 1874, there was available for the improvement of this harbor (including the $6,000 appropriated by Act of June 23, 1874),—

The sum of	$6,103 48
Amount expended from July 1st to December 31, 1874, .	4,817 03
Amount available, January 1, 1875, ...	$1,286 45

The above amount expended since July 1, 1874, has been applied to building a bulkhead and jetties for the preservation of the beach at Cove Section, where encroached upon by the extraordinary gales of November, 1873, and January, 1874, as well as by subsequent gales; to increasing the outer end of the stone bulkhead on Long Point; and to the repair of the bulkhead and jetties on Beach Point, where most necessary.

The bulkhead and jetties at Cove Section were commenced in September and completed early in December, 1874. They are built of a framework filled with brush and ballasted with stone. The bulkhead is 607 feet in length; and the jetties, six in number, have an aggregate length of 126 feet.

Since the completion of this work, its efficiency has been most successfully tested by a violent storm, which rushed over the beach and filled the space in front of the work to a depth of two to three feet with sand, adding greatly to its strength.

[C.]

EXTRACTS FROM ANNUAL REPORT

UPON THE IMPROVEMENT OF RIVERS AND HARBORS IN PART OF THE STATE OF MASSACHUSETTS IN CHARGE OF G. K. WARREN, MAJOR OF ENGINEERS, BREVET MAJOR-GENERAL U. S. A.

HYANNIS BREAKWATER.

During the past fiscal year, the appropriation of $10,000 made by the Act of Congress, approved March 3,1873, has been expended in the rebuilding and repairing of about 220 feet of the west end of the breakwater.

This work has been conducted with especial reference to making the wall above low water as solid as possible, so that it may best resist the force of the waves, and to bringing the slopes under water up to the angle required to insure permanence, which we think is attained here by making the seaward slope 1 upon 2 and the other 1 upon 1.

The west end, for the length of 220 feet, is now in a proper condition, but, as stated in my last report on this improvement, the remaining length of the breakwater is in an unsafe condition below low water. Many gaps exist in the seaward slope, which, together with its steepness, demand early repairs to prevent a breach in the parapet.

The estimates given below are for this purpose:—

4,000 tons of riprap granite, at $3.50 per ton, . . .	$14,000 00
Superintendence, etc., 10 per cent., ...	1,400 00
	$15,400 00

I deemed it advisable to make a survey of the harbor, sheltered by the breakwater, for the purpose of ascertaining the need and probable cost of enlarging the anchorage-ground by dredging, and herewith transmit a map of the same, and also the report of Mr. P. M. Blake, assistant engineer, who had charge of the work.

I find that a greater depth exists than shown on the Coast Survey chart of Hyannis Harbor for 1850, while the area available for vessels drawing more than nine feet is sufficiently large at present for the use of the coasting-trade.

All that is now needed to make this work permanently safe is a sufficient amount of riprap, properly placed, and the appropriation of

$5,000 for the present year will be used, so far as it will go, toward the accomplishment of this object. I estimate that $10,000 more will be required to complete these necessary repairs, and urge that an appropriation for that amount be made for the fiscal year ending June 30, 1876.

The removal of the light-house, as suggested in my former report, from its present position to the east end of the breakwater, is again recommended.

Wareham Harbor.

At the close of my last annual report, August 30, 1873, the dredging operations under the appropriation of $10,000, approved June 10, 1872, had just been finished; those under the appropriation of $10,000, approved March 3, 1873, were begun September 1. Everything in regard to proposals, etc., for doing this work was given in my last annual report.

Before any improvement was made here, a depth of 7½ feet at mean low-water (11½ feet at high-water) was the greatest depth that could be found over the bars, and only in very high tides could the latter depth be found over the ridge just below the wharves. The channel was, besides, so very crooked, and the form of the harbor such that vessels could only sail up or down with favorable winds, and the business of the town not warranting a tug, navigators were subjected to vexatious delays and losses.

The first appropriation of $10,000 was sufficient to complete a channel 200 feet wide, through a ridge connecting the east shore with the main portion of Quahaug Bar, of which it may be said to have formed a part, thus affording a tolerably straight passage around the main portion of the bar, which was not touched. Dredging was also begun on the upper bar.

With the second appropriation of $10,000, dredging was continued on the upper bar until the funds were exhausted, November 25, 1873. A channel about 120 feet wide was made around the upper bar, and the depth of 9 feet extended up to the town, leaving a channel nowhere of less width than 60 feet.

A large rock, weighing 28 tons, was also removed from the channel.

The amount of material removed during the working season of 1873, under both appropriations, which includes all that has so far been done besides the new survey and map, is as follows:—

From near Quahaug Bar, ...	21,862 cubic yards.
From near upper bar and up to the wharves, .	24,901 " "
Total, ...	46,763 cubic yards.

The further improvement of this harbor will require dredging at Quahaug Bar, to remove points where there is less depth than 9 feet at mean low-water, so as to make the channel there 200 feet wide and 9 feet deep; to remove a shoal opposite Barney's Point; to remove the main point of the upper bar and to widen above it, so as to make the 9-foot channel at least 100 feet wide in the straight portions and a somewhat greater width at the bends, to compensate for the greater room required by vessels in turning,

In the report of the first survey, made in October, 1871, was one estimate for removing ledge and bowlder in Weweantic River, of $3,000. It does not seem now that the removing of these properly belong to the improvement of Wareham Harbor, but there are rocks in the channel leading to Wareham Harbor, just off the mouth of the Weweantic River, which have never been examined by us, and which should be removed, if practicable. We provisionally estimate the removal of these at $3,000. The location of them is shown by four buoys, and the place is known to navigators as "Four Buoys."

The following is the estimate of the amount of work still required for the improvement of Wareham Harbor, as far as present interests will justify:—

Dredging on upper bar and vicinity, 24,107 cubic yards, at 35 cents, ...	$8,437 45
Dredging opposite Barney's Point, 1,401 cubic yards, at 35 cents, ...	490 35
Dredging Quahaug Bar and vicinity, 15,678 cubic yards, at 35 cents, ...	5,487 30
Removal of rocks at Four Buoys (approximate), . . .	3,000 00
Engineering and contingencies, ...	2,584 90
	$20,000 00

Amount on hand (appropriation approved June 23, 1874), .	$10,000 00
Amount required in addition, ...	10,000 00

It is proposed to do this work by contract. Wareham is the centre of an iron-manufacturing business, using a large quantity of iron and coal, nearly all of which is brought in through this channel.

This harbor is a port of delivery. It is in the New Bedford collection-district, and New Bedford is the nearest port of entry. The amount of revenue collected there during the fiscal year ending June 30, 1874, was $21,095.47.

Taunton River.

At the date of my last annual report, August 30, 1873, the removal of bowlders from this river was in progress; it was continued until October 10, when the portion of the appropriation assigned to this purpose was expended; it has been productive of much good.

A contract for dredging, at $2 per cubic yard, had been made with Mr. E. R. Seward, of Albany, N. Y., he to begin June 1, 1873, and complete November 30, 1873. His contract was afterward extended to June 30, 1874, to allow him time to finish the work at Norwalk, Conn., under my charge, before beginning this. The dredging was diligently prosecuted from October 24 to November 26, 1873, and again from March 11 to March 31, 1874, when the appropriation was expended. The shoals known as Blake's Table Rock and Sheep Pen were thoroughly removed, and a cut about 25 feet wide and 600 feet long was made through Chabbot Rock Shoal, the depth of each being 9 feet at mean high water The following is the amount of work done:—

Material dredged, ...	3,443.42	cubic yards
Rocks and stones removed, ...	224.50	" "

On the completion of work, a survey was made of the channel dredged and of several obstructions near Dighton, detailed examinations of which had never been made.

The future work contemplated is the removal of the remainder of the upper shoals, by dredging, and of the obstructions from Berkley bridge to Dighton, consisting of dredgeable materials and rocks.

The estimate for the whole improvement is somewhat increased over that of last year by the addition of the estimate for the shoals near Dighton, not before included, and for other minor reasons stated in the annexed report of my assistant.

Dredging, at $2 per cubic yard for upper shoals, and 50 cents lower, ...	$16,470 50
Removal of rock, at $8 per cubic yard, ...	2,400 00
Engineering expenses and contingencies, ...	3,129 50
Total, ...	$22,000 00
Less appropriation for fiscal year ending June 30, 1875, .	10,000 00
For year ending June 30, 1876, ...	$12,000 00

All of this could be advantageously expended in one year.

SURVEY OF WOOD'S HOLE.

This is one of the surveys directed by the Act for improvement of rivers and harbors, approved March 3, 1873, which has been intrusted to me.

In the estimates submitted, the smallest one, $5,000, will remove a few of the worst rocks that now interfere with the running of the steamboats between New Bedford and Martha's Vineyard. This improvement will be of benefit principally to them. It is much more advisable, however, to appropriate the $22,000 estimated for a more thorough removal of the bowlders. This will be of benefit to a large number of sail-vessels, and a great deal more good can be done with it, in its proportion, than with the smaller sum, because it is a difficult place to operate in, and the necessary preparations will consume a large part of the smaller amount and leave but little to work with. When adequate preparations are once made, it is very desirable to continue the work until it reaches a satisfactory conclusion.

Our estimate further includes a larger sum for continuing the improvement by dredging, and otherwise to enlarge the passage to a capacity adapted to the use of our coastwise sailing fleet, whenever it is advantageous to make the passage through Buzzard's Bay instead of the opposite portion of the Sound. It may be too soon to begin this now, but it will ultimately be necessary; and, while upon the subject, we have made our plans complete and looking toward such final accomplishment. All the partial improvements proposed are, as far as they go, directed toward this final end, while at the same time affording the greatest benefit.

This improvement may truly be called a national one. It is not for the benefit of the special locality. It is for a navigable highway, uniting two large bodies of navigable water extensively used by the commercial vessels of the United States, and when thoroughly improved it will tend greatly to a saving of time and diminish the dangers of navigation. The circumstances under which its use is particularly desirable, and the reasons for it in detail, are given in Mr. Cotton's report.

In conclusion, I would say that I consider $22,000 as the most desirable amount with which to begin this work.

In 1852 there was an appropriation of $2,500 made for the improvement of Great Wood's Hole Harbor. This was spent in building a breakwater on its northern side to close a passage through which water passed between it and Buzzard's Bay. The report of this operation is found in the Annual Report of the Chief of Engineers for 1853. It would appear that the work was left incomplete, as an additional appropriation of $2,000 was solicited. Private parties have, however, since continued the work, and occupied the vicinity, so that the opening is entirely closed at the present time.

SURVEY OF THE HARBOR OF FALL RIVER.

This survey was authorized by the Act of Congress, approved March 3, 1873, and was, as stated in the Act, made with a view to the removal of rocks from this harbor.

This survey extends along the harbor-front about 1,500 feet, between Rodman's wharf and Brown's wharf, and out to the curve of 14 feet depth at mean low-water.

The most obvious obstructions in this space are bowlder-rocks of all sizes up to several tons weight; but besides these the surface on which they lie is too shoal, and requires dredging.

We have made an estimate for the removal of the rocks and the dredging separately, and also for a few dolphins to mark out the channel, when improved, and to guide and aid vessels in getting in and out.

The improved channel thus to be provided is to be 12 feet deep at mean low-water, and 100 feet wide at the narrowest parts, widening out at each end, where it joins the main channel.

The estimate is as follows:—

For removing bowlders,	$11,000 00
For dredging,	33,400 00
For six dolphins,	600 00
	$45,000 00

The Act of Congress, approved June 23, 1874, appropriated $10,000 for the removal of bowlders from this harbor. It is proposed to extend this in the removal of bowlders by contract, after advertising in the usual manner.

The work will probably be done this autumn and the following spring.

The whole estimate of the improvements at this place was $45,000. The present appropriation will probably enable us to remove most of the bowlders, leaving the dredging and putting in dolphins to mark the channel till further means are provided.

It would be most economical to have all the rest of the estimate ($35,000) at one time, and it could all be advantageously expended in one year. The full value of removing the bowlders will not be realized until the whole work is done.

Fall River city is a most commercial place, and too well known to need special mention here. It is a port of entry, and the amount of revenue collected in the fiscal year ending June 30, 1873, was $212,491.42.

The revenue collected during the fiscal year ending June 30, 1874, was $93,128.23.

[D.]

RETIREMENT OF HON. DARWIN E. WARE.

The Board of Harbor Commissioners was establised by Act of July 1, 1866, and the Commissioners were appointed by Governor Bullock. Mr. Ware was one of the original members so appointed. At the expiration of his first term of two years' service, he was reappointed by Governor Bullock, and at the expiration of his second term of five years' service, he was again reappointed by Governor Washburn. Mr. Ware tendered his resignation in October, to take effect when a new Commission was appointed, and continued to act with the Board up to December 12.

It is no injustice to the other members of the Board to say that a laborious part of its duties and responsibilities have been borne by Mr. Ware. His legal knowledge and judgment in dealing with the complicated questions connected with the work of the Commission, has been of a value to the Commonwealth which it desires to record.

On the announcement of his resignation, the following resolutions were adopted :—

Resolved, That we learn with regret that the Hon. Darwin E. Ware has resigned his position as a member of this Board; we embrace this opportunity which the occasion furnishes to place upon our records our sense of the value of his services to the Commonwealth, and our appreciation of his merits as an associate and friend.

Becoming a member of the Board upon its original organization in 1866, he was instrumental in shaping its policy and methods; his time and eminent legal talents have been promptly rendered to its service whenever required, and we feel that to him, in a large measure, it is indebted for its past success and the reputation it enjoys as an important department in the administration of the affairs of the state.

Resolved, That we tender to him our heartfelt wishes for his continued prosperity and happiness; we part with him officially with many pleasant recollections of his courtesy and kind feelings while in the discharge of the public duties in which we mutually have been engaged.

[E.]

[Chap. 34, Resolves of 1874.]

RESOLVE IN RELATION TO THE FLATS, MEADOWS AND BEACHES ON EAST HARBOR CREEK IN PROVINCETOWN AND TRURO.

Resolved, That the board of harbor commissioners is hereby authorized to compromise and settle in behalf of the Commonwealth any demands, that seem to the board just, of any persons or corporations, for injuries resulting to meadows, flats and beaches, in Truro and Provincetown, in the county of Barnstable, from the construction by the Commonwealth of a dike across the outlet of East Harbor, or to purchase in behalf of the Commonwealth the fee of said meadows, flats and beaches, or of any part of them, and to receive on behalf of the Commonwealth conveyances or releases of the same, or agreements concerning the same: *provided, however*, that such settlements, purchases, conveyances, releases or agreements shall be subject to the approval of the governor and council; and that there shall be allowed and paid out of the treasury of the Commonwealth for the purposes of this resolve a sum not exceeding ten thousand dollars, and the harbor commissioners may in making any purchase of any said meadows, flats and beaches, or after the same have been conveyed to the Commonwealth make any agreements concerning future occupation of the same or concerning any rights or interests of persons or corporations in the same which to said board may seem fit and proper, subject, however, to the approval of the governor and council. *Approved April 21, 1874.*

[Chapter 347, Acts of 1874.]

AN ACT IN RELATION TO STRUCTURES IN TIDE-WATERS.

Be it enacted, &c., as follows:

SECTION 1. The board of harbor commissioners is authorized and empowered to license any person to build or extend any wharf, construct any pier, dam, sea-wall, road, bridge or other structure, or to fill land or flats below high-water mark and beyond the line of riparian ownership in and over tide-water along the shore of which no commissioners' or harbor line has been established by law: *pro-*

vided, however, that no such license shall have any validity beyond the line of riparian ownership unless approved by the governor and council; and *provided, further*, that no such license shall be granted under the authority of this act for the construction of a bridge across any river, cove or inlet in any location not above the line of some existing bridge or other structure authorized by law over such tidewater in which there is in fact no draw and in which the law does not require that a draw be constructed or maintained or in case the mayor and aldermen of the city or the selectmen of the town within the limits of which the work licensed is to be done shall after the notice to them required by law appear and oppose the granting of the same. But the recital in such license that no such opposition has been made and the recital in any license of the said board that the notice required by law has been given shall be conclusive evidence of the facts recited.

SECTION 2. Every license granted under the authority of this act shall be subject to the provisions of the third and fourth sections of the two hundred and thirty-sixth chapter of the acts of the year eighteen hundred and seventy-two.

SECTION 3. This act shall take effect upon its passage. *Approved June 19, 1874.*

PUBLIC DOCUMENT..... .....No. 33.

13

ANNUAL REPORT

OF THE

BOARD OF HARBOR COMMISSIONERS

FOR

THE YEAR 1878.

BOSTON:
Rand, Avery, & Co., Printers to the Commonwealth,
117 Franklin Street.
1879.

Commonwealth of Massachusetts.

HARBOR COMMISSIONERS' REPORT.

To the Honorable the Senate and the House of Representatives of the Commonwealth of Massachusetts.

The Board of Harbor Commissioners, in accordance with the provisions of law, respectfully submit their Annual Report for the year 1878.

South Boston Flats.

The substantial completion of work under the Clapp and Ballou contracts was announced in the last Annual Report. The possession of the filled territory has been transferred to the Land Commissioners, together with all personal property of the Commonwealth used in connection with the work of reclamation. A tabular statement of the precise location of points, which was not completed at the time of the last report, with plan illustrating the same, will be found in the Appendix.

The contractors' claims for extras, damages, &c., which were under examination at the time of the last report, seemed to the Commissioners entirely untenable as to the principal items, and they were unable to adjust the same with the contractors; but all items which seemed to them to have any equitable foundation, amounting to $4,548.81, were allowed and paid. A petition was then presented by the contractors to the Governor and Council, who were the arbiters provided by the contract, submitting a claim for the items disallowed by the Commissioners, amounting to $201,709.41. While this petition was pending, and before hearing upon its merits, a board of arbitrators was created by chap. 281 of the Acts of 1878, and authority given to the Harbor Commissioners to join the contractors in a submission of the claims in question to the board thus established. It was supposed, at the time of the passage of the Act, that the hearing before the arbitrators would proceed at once in the month of June. Mr. Philbrick the engineer, and Mr. Osgood the inspector, who had been retained in service during the investigation of the claim by the board, were continued till the 1st of July, in expectation of an early assignment of the hearing. Difficulties arising out of proceedings in bankruptcy against the contractors continued to prevent the execution of the submission; and the board did not feel justified in continuing the employment of Messrs. Philbrick and Osgood, in view of the entire uncertainty when the submission could proceed. The proceedings in bankruptcy were dismissed on the 20th of September; and the board were immediately afterward informed by the counsel for the contractors of the removal of all obstacles to the submission, and of their readiness to proceed. The illness and death of Judge Thomas, the counsel for the board, occasioned some further delay in perfecting the formal submission; but, on the 16th of October, the submission agreement, in the form as it had been approved by Judge Thomas, was executed. Other counsel approved by the Governor and Council, were employed; and the arbitrators assigned the 16th of January, 1879, for the commencement of the hearing. Immediately after this assignment, the board communicated with Mr. Osgood, then in the employ of the Atchinson, Topeka, and Santa Fé Railroad Company, and were surprised to learn that it would not be practicable to secure his presence East before spring, by reason of the pressure of his employment at the West. Mr. Osgood's intimate knowledge of all the details of the work out of which the claims in question arise renders his presence at the hearing of great importance; and, if it were to proceed to a conclusion in his absence, the Commonwealth's interests would be at great disadvantage. It may be necessary for this reason to extend the time within which the arbitrators' award must be returned to the court under the provisions of the Act before cited.

The failure of the Boston and Albany Railroad Company to complete the filling of the 50 acres purchased of the State by them, and to construct the sea wall in front of the same, hinders the progress of the harbor improvement contemplated by the entire reclamation; but the Commonwealth having completed the 25-acre parcel, it is hoped that steps will be taken by the company to proceed to the completion of the wall and the dredging required of them, without further delay.

DREDGING IN BOSTON UPPER HARBOR.

The dredging in progress upon the shoal ground off East Boston frontage, at the time of the last Annual Report under contract with W. S. Fretch & Co., has been completed. Dredging has been continued upon the same shoal within the year, which has further extended the area of 23 feet depth, at mean low tide, one hundred and fifty-five thousand five hundred and seventy (155,570) square feet. The contract for this dredging was made with Charles Woolley & Co., on the 26th day of June; and the work was completed, and tested by soundings made by the engineer of the board, on the 13th day of December. The contract price was $9,909, the contractor taking all risk of quantities and character of the material. The amount of earth removed from the shoal, as measured in bank by the board, was 36,000 cubic yards. The material removed was placed upon the Commonwealth flats at South Boston. The work under this contract was executed in a manner entirely satisfactory to the board, and creditable to the contractors.

The removal of the shoal at East Boston has already proved a most timely aid in the provision of facilities for the increased number of foreign steamers of large draft. The removal was not commenced too soon, nor has it proceeded more rapidly than the actual demands of commerce have required. It has illustrated the great advantage to the harbor of a fund from which expenditure can be made in the intermediate ground between what may be left to individual enterprise and what may be expected from the general government.

RE-SURVEY OF THE WHARF LINES OF BOSTON UPPER HARBOR.

Since the last Annual Report, the re-survey of Boston Upper Harbor has been continued to a satisfactory completion of the field work within the limits contemplated with the special appropriation provided. There remains some work in the completion of maps and extending soundings, which will be made in connection with the regular office work of the Board, without further special appropriation.

The character and purposes of the re-survey have been indicated in former reports of the Board for 1876 and 1877. Among the essential auxiliaries to the studies and work of the commission are accurate maps and plans, which must be kept up, or renewed from time to time as data from them are required. In providing for this necessity by the present re-survey, the occasion presented an opportunity to establish a system of survey which should secure accuracy in determination, and uniformity in detail, and furnish bases and references which would facilitate and economize the execution of future re-surveys, and at the same time give exact comparison of results. The Board were unanimous in adopting the system of geodetic survey which obtains in the United States Coast Survey. There were no means of securing this result so advantageously as by the co-operation of that department; which was satisfactorily arranged with its superintendent, Hon. C. P. Patterson.

As will be seen by reference to the report of Mr. Francis Blake, jun., assistant in the Coast Survey, in the Appendix, the extent and cost of the triangulation have exceeded the original estimates made for it; but the work has also exceeded the original plan in comprehensiveness, and has furnished bases and data of great present and prospective value. The loss of the triangulation stations of the Coast Survey within the city by the change and rebuilding of spires and conspicuous buildings, and the destruction of markings upon the hills and islands which surround the city, is a proof and admonition of the importance of establishing numerous and securely-marked points of reference, and providing for their protection. As stated in Mr. Blake's report, the main points in the new triangulation have been marked by granite posts and copper bolts. These stations are upon commanding sites overlooking the city, and include the summits of Blue Hill in Milton, Prospect Hill in Waltham, Powderhorn Hill in Chelsea, Winthrop Head, Breed's Hill, Governor's Island, &c. Besides these points, many spires, cupolas, factory chimneys, &c., have been determined within the city. The total number of points determined by triangulation amounts to 67. The more general knowledge of the existence of these points, their more conspicuous marking, and the frequent future use which will probably be made of them, will tend to their preservation.

The topographical work of the re-survey has been executed by Mr. William E. McClintock, formerly of the United States Coast Survey, and has been under the general supervision of Professor Henry L. Whiting of that department. The instrument used, the "plane table," and the mode of work adopted, are those which are standard in the Coast Survey. The scale and measurements of the re-survey conform to the metric system which obtains in the Coast Survey. The results are given upon a series of twelve original plane-table sheets, which are each about thirty by fifty-two inches in size. Eleven of these sheets are on the scale of $\frac{1}{1000}$, and cover the wharf lines of the Upper Harbor, including Fort Point Channel, the South Boston sea walls and dock, the east and north water-face of the city proper, Charles River from the Navy Yard to West Boston Bridge, Chelsea Creek from the Navy Yard to Meridian Street and Chelsea Bridges, with the improvements of the Lowell Railroad Company and the south channel of Mystic River, and the water-face of East Boston as far as it is improved. One sheet, on a scale of $\frac{1}{2000}$, includes the shore-lines of Cambridge basin, between West Boston and Brookline Bridges. As stated in the report of Professor Whiting, in the Appendix, upon these sheets are shown all required details along the harbor frontage, with measurements connecting them with the points and corners in the marginal streets, which are also established points in the framework of the city determined by its engineers.

Besides the triangulation and topography, a series of soundings have been made along the city frontage, which show the depth of water in each dock, and at the end of each pier, and beyond the general pier-line, for a distance of 60 feet into the channel.

This work also includes the hydrographical re-survey of Fort Point Channel from Eastern Avenue to Dover Street Bridge. The former harbor surveys have not included these details; and the Board has had no previous reliable data concerning the commercial capacity of the city docks and piers. By a closer degree of economy in the execution of the topographical part of the survey than was at first deemed practicable, the results of this work have nearly if not quite come up to the original project for it, and cover most of the wharf-lines of the Upper Harbor at present utilized in important commerce.

One of the special purposes to which the data of the re-survey will be applied is the study of the harbor lines with a view to a re-statement, or of such re-determination and modification, of the existing lines as their uncertain and defective condition may require. Upon completion of the maps, and a careful study of all the results of the re-survey, the Board expect to present a re-statement of the lines which may be more safely embodied in legislation than any which they are now prepared to propose. As stated in the report of 1876, the present harbor lines were established by various and independent acts of the Legislature, some of them dating back over 40 years. During this lapse of time many of the original reference points have been lost by the obliteration of old landmarks and in the changes occasioned by the erection of new structures, many of which were authorized without due regard to the prescribed harbor boundaries. These changes occurred prior to the establishment of the permanent commission in 1866, since which time no important encroachments have been made.

Green Harbor River.

A bill in equity has been brought by the attorney-general, under the provisions of chap. 219 of the Acts of 1877, to compel the parties liable under chap. 303 of the Acts of 1871 to remove the shoaling occasioned in the channel of Green Harbor River. The bill was filed in May last, and is still pending. Nothing has occurred to change the views of the Commissioners expressed in previous reports in relation to the injuries to this harbor arising from the erection of the dike.

SCITUATE HARBOR.

The condition of Scituate Harbor has enlisted the active interest of the citizens of that town, and of several organizations interested in the safety of vessels approaching Boston; and a strong movement has been made to induce the United States to make an appropriation for the improvement of the entrance. Hon. George Lunt, now a resident of Scituate, has collected and presented much valuable information in relation to the history of the harbor and its use as a port of refuge. A memorial of this Board in aid of the movement has been presented to Congress, a copy of which will be found in the Appendix. Congress has already ordered a survey of the harbor, which has been made under the direction of Gen. Thom of the U. S. Engineer Department.

STATE SUPERVISION OF HARBORS.

The Commonwealth has always claimed extended rights in, and control over, tide-water. The duties growing out of the rights and control thus claimed have not been denied. The present system of preserving and developing public interests in the harbors of the Commonwealth was of slow growth, from a series of experiments and studies which it may be of use to review briefly in any new study of methods of administration which the depressed condition of business may occasion.

The colony ordinance of 1641 attests early legislative attention to the relation of private and public interests in the sea and lands under tide-water. By that ordinance the rule of common law, which gave to the State exclusive ownership below high water, was so far reversed, that private title was made to extend one hundred rods into the sea from high-water mark, or to low water when not more than that distance. There has been no more radical change in the law affecting this public interest than that caused by the ordinance in question. It complicated the problem of preserving and developing the interests of the public, and has been fruitful in occasion for legislation and in litigation; but it vested rights beyond recall.

Statutes for the protection of the different harbors of the

Commonwealth, and in relation to the erection of structures in tide-water, were frequent from the adoption of the constitution; but the growth of the State, and the increased use of its principal harbors, early induced the Legislature to make use of other agencies to secure more systematic and complete knowledge of the needs of such harbors, and what could be safely permitted in the construction of wharves and other structures therein.

Under a resolve of March 5, 1835, a commission consisting of Loammi Baldwin, S. Thayer, and James Hayward, all engineers of high attainments, was appointed by Gov. Davis "To cause a survey to be taken of such portions of the harbor of Boston as are comprised between Boston South Bridge and the dam of the Boston and Roxbury Mill Corporation, including the wharves and flats of East Boston and of Charlestown; and to define, upon a plan or plans, such lines as they shall think it expedient to establish, beyond which no wharves shall be extended into and over the tide-water of the Commonwealth on either side of said harbor; and report their doings to the Governor and Council. The commission thus appointed occupied nearly two years in the work assigned them; and submitted their report Jan. 30, 1837, in which they state forcible reasons why the full enjoyment of the rights thought to be given by the ordinance of 1641 would be inconsistent with the existence of the harbor. Chap. 229 of the Acts of 1837, establishing a harbor-line for the principal front in Boston Harbor, was based upon the report of this commission; and the line then established has continued without material alteration to the present time, though some of its points have become difficult of location from the destruction or change of structures then used for reference-points. It is believed, however, that when the results of the latest re-survey are fully extended upon the maps, little more will be found necessary than a re-statement of the old line by reference to new monuments more easily ascertained.

Two years later, under a resolve of April 9, 1839, a second commission, consisting of H. A. S. Dearborn, James F. Baldwin, and Caleb Eddy, was appointed to define such further lines upon either side of the harbor of Boston as they should think expedient, beyond which no wharves should be extended. The report of this commission was one of the most thoughtful and suggestive of the series in which the harbor questions have been presented. Upon its recommendation further harbor-lines were established by chap. 35 of the Acts of 1840.

Five years later, under a resolve of March 22, 1845, a third commission for a similar purpose was appointed, which consisted of James Hayward and Ezra Lincoln, jun. This commission submitted, the year following, a report containing much information in regard to South Bay, Mystic River, and Charles River; and upon its recommendation new harbor-lines were established in those localities by chap. 278 of the Acts of 1847.

A fourth commission, consisting of Joseph Bell and Ezra Lincoln, jun., appointed under a resolve of April 16, 1846, had first examined the legal questions involved in the recommendations of the commission of 1845, and had reported conclusions since fully sustained by the courts.

A fifth commission, consisting of Thomas G. Cary, Simeon Borden, and Ezra Lincoln, was appointed under a resolve of the same date, to examine the flats at South Boston with a view to a plan of improvement thereof beneficial to commerce; and made, Feb. 2, 1847, a careful report, which discussed the probable effect of the reclamation of the flats in question upon the harbor, and advised great caution in relation thereto.

A sixth commission, consisting of Samuel S. Lewis and Ezra Lincoln, jun., was appointed under resolve of April 7, 1847, in relation to a survey of Boston Harbor, and was instructed by an additional resolve, May 10, 1848, to present lines for a harbor-line in Chelsea Creek; also to ascertain whether obstructions were forming in Fort Point Channel, and whether legislation was necessary to prevent or remove the same. In its report, this commission recognize the principle of requiring compensation from those authorized to extend structures into tide-water, and recommend that the proprietors of certain wharves be required to remove the bar in Fort Point Channel as a condition of extending their wharves to a new line.

The seventh commission was appointed under resolve of May 10, 1843, "To consider, and report to the next Legislature, what are the rights and duties of the Commonwealth in relation to the flats in the harbor of Boston." Other duties were assigned specifically, but the report of the commission treated principally the comprehensive subject committed to it. A brief report was submitted in 1849, signed by Richard Fletcher, David Cummings, George S. Boutwell, and Charles Hudson; and the final report was submitted in January, 1850, signed by John M. Williams, David Cummings, Thomas Hopkinson, George S. Boutwell, and Charles Hudson. Under the head of the rights of the Commonwealth, the legal position was stated with great clearness. In regard to the duties of the State, this commission differed from the conclusions of previous commissions, and advised against the filling of the South Boston flats; predicting that in 50 years the utmost capacity of the harbor would be required, and contending that nothing should be filled which is capable, by excavation, of being converted at a reasonable expense into wet docks or roadsteads.

The eighth commission consisted of Simon Greenleaf, Joel Giles, and Ezra Lincoln, jun., and was appointed under a resolve of May 3, 1850. Its first report is dated March 22, 1851. The legal questions involved in the State's relations to tide-water are again exhaustively discussed in this report; also the expediency of filling the flats at South Boston, and harbor lines in South Bay. A permanent board of trustees or commissioners is recommended. The final report was presented March 11, 1852, in which the establishment of a State commission upon Boston Harbor and its tributary waters was again recommended.

Under resolve of May 20, 1852, probably passed upon the recommendation last cited, a ninth commission was appointed, — the first of a permanent character, — which was termed the Commissioners on Boston Harbor and the Back Bay. The duties of this board seem to have been principally confined to the interests of the Commonwealth in the Back Bay; and in 1855 the name was changed, so that it was afterwards known as the Commissioners on the Back Bay.

Under resolve of April 7, 1854, a tenth commission was appointed, to establish lines in Mystic River, Boston Harbor, and Dorchester Bay. This board consisted of Henry W. Kinsman, Charles Henry Davis, and Edward H. Eldredge.

A partial report was made in December, 1854; and a final report Feb. 28, 1855, in which the commissioners say that the recommendation to which they attach the highest importance is, "that the care and superintendence of the whole harbor and its dependencies, or of all the tide-waters of Massachusetts, be assigned to a permanent board, or some other standing authority;" and again: "They cannot take"
" leave of the subject without once more referring to the "
" imperative necessity now existing of establishing a perma- "
" nent Board of Harbor Commissioners. The conditions "
" herein recommended as of the first importance, in connec- "
" tion with any improvements which the Legislature may "
" hereafter authorize in either of the great tidal reservoirs, "
" — the continued building of new wharves, and extension "
" of old ones; the filling up of docks and flats to the exclu- "
" sion of the tide; the consequent diversion of currents to "
" a greater or less degree; the changes which have taken "
" place in the channels, and the causes which have pro- "
" duced these changes, — all point to the necessity of a "
" continued supervision. Much good has resulted from the "
" examinations made by the several commissions heretofore "
" appointed; but the results, so far as the protection of this "
" great public interest is concerned, would undoubtedly "
" have been much more beneficial, while the expense would "
" not probably have been greater, had a permanent board "
" been continued from the year 1835 to the present time. "
" It is manifest that every new board of commissioners, and "
" every new committee of the Legislature, having the sub- "
" ject in charge, must encounter great difficulties from their "
" want of previous acquaintance with it. In the liability "
" to an entire change from year to year in the formation of "
" these bodies is to be found an additional reason, namely, "
" that the time occupied in learning the duties of its charge "
" is so much lost to the full performance of its functions. "
" The experience of one board does not descend to its suc- "
" cessors. It should be made the duty of such a commis- "
" sion to see that the works allowed to be erected within it "
" should do no injury, or the least possible injury, to the "
" harbor; that they should be what they were authorized "
" to be, and nothing more; that plans should be made of all "
" such structures, and careful observations recorded of their "

"effect upon the channels. Accurate surveys of the islands" "and headlands should be made yearly, and the result delineated upon plans drawn upon a large scale, so as to" "show the comparative abrasions of their soil, one season" "with another, and direct attention to the points most seriously affected by the action of the sea. By this means" "also the formation of shoals and spits, and the changes" "of the current injurious to the main channels of the harbor, would be accurately known and defined. Annual" "reports made by such a commission would communicate" "authentic information, and would gradually become a collection of great historic and practical value."

In 1859 the land-office, which had been abolished in 1858, was revived, and the land-agent was given in charge all lands, flats, shores, and rights in tide-waters belonging to the Commonwealth, except the Back-bay lands and other lands then provided for by law; and by the same resolve the Governor and Council were given powers in relation to the permission of structures in tide-water similar to those afterward given to the Harbor Commission. The land-office was again abolished in 1861; and the duties of the land-agent were assigned to the Commissioners on the Back Bay, who were thereafter termed the Commissioners on Public Lands.

In 1856 and 1858 the Legislature passed resolves requesting Congress to direct a scientific survey of Boston Harbor; but the survey was not obtained until the city of Boston supplemented the efforts of the Legislature by an appropriation for expenses connected with the same, when the work was thoroughly executed under the direction of United States officers. The results obtained from the survey thus made have been of great service in all subsequent studies of the harbor, and will continue to be of use as long as the harbor shall require care.

The eleventh commission was appointed under resolves of April 28, 1862, and was termed the Commissioners on the Harbors and Flats of the Commonwealth. Its first report was made Jan. 15, 1863, and signed by F. W. Bird and Horace Gray. A second report, made after the completion of the survey of Boston Harbor, was dated March 22, 1864, and signed by Emory Washburn and Horace Gray, in which the importance of a permanent commission, who should have in charge the interests of the harbor, was urged. A third report, dated Feb. 24, 1865, transmitted the ninth report of the United States commissioners. A fourth report was made Jan. 16, 1866, signed by S. E. Sewall, George B. Upton, and M. D. Ross, in which the following language is used: "In regard to a general system for the care, improvement, and protection of the harbors, we must recommend, as those who have preceded us as a commission have done, the creation of a permanent board of harbor commissioners, to have the supervision of all the harbors and flats of the State;" and considerable space is given to an explanation of the work which existed for such board.

Chap. 149 of the Acts of 1866 established a board of harbor commissioners, consisting of five persons, to be appointed by the Governor. This commission was reduced in 1877 to three members, but without change of duties or name, and may be properly considered the present system. The board thus established were given the general care and supervision of all the harbors and tide-waters, and of all the flats and lands flowed thereby, within the Commonwealth, except the Back-bay lands so called, with power to make surveys, examinations, and observations in any harbor as they may deem necessary, and to employ competent engineers, clerical and other assistance. They were also authorized to prescribe harbor-lines to be reported for the consideration of the Legislature, and to approve the mode of extending structures below high-water mark. In all cases affecting the harbor of Boston, and in cases affecting other harbors when the board should think it necessary, they were required to ascertain the amount of tide-water displaced by any structure or filling thereafter authorized, and require the parties causing the same to make compensation therefor by excavation or a money equivalent, the money thus obtained to constitute a fund applicable to the protection and improvement of the harbor from which it is collected. They were also authorized, whenever they deemed it necessary, to apply to Congress for appropriations for protecting and improving any harbor in the Commonwealth, and to recommend such State legislation as they deemed necessary for the preservation and improvement of the harbors, and the promotion of the interests of the Commonwealth connected therewith. The powers of the

Board in relation to structures were extended by chap. 236 of the Acts of 1872 and chap. 347 of the Acts of 1874. The care of the property interests of the Commonwealth in South Boston flats was transferred from the Harbor Commission to State agents by chap. 239 of the Acts of 1875. The provisions in relation to compensation for tide-water displaced were modified by chap. 74 of the Acts of 1878.

The present system has existed a little more than twelve years, during which the more important harbors of the Commonwealth have been the subjects of careful study by the Board and its engineers. A large number of structures have been authorized in the harbors of Boston and Gloucester, a considerable number in the harbor of Provincetown, and some in nearly every harbor of the Commonwealth. Special surveys and examinations of permanent value have been made in some of the smaller harbors, as well as in those of greater prominence. The Legislature has been relieved of a large number of matters pertaining to the erection or extension of wharves and other structures, important in the aggregate, but consuming time of the Legislature disproportioned to their importance when considered in detail. In the great commercial port of the Commonwealth, through the expenditures of the United States, the enterprise of the State, and the exertion of individuals stimulated by both, great improvements have been effected; and the harbor is in much better condition than ever before to meet the needs of its growing foreign commerce. The special fund for its protection, derived from assessments for tide-water displaced, already amounts to $131,460.44, the annual interest of which may be expended under the direction of the Harbor Commissioners for needed improvements. There has been expended from this source, for deepening the inner harbor at points which the United States have not been willing to embrace within any scheme of improvement hitherto projected at the national charge, the sum of $41,300.17; and the deepening thus effected has been immediately utilized by large steamers engaged in the foreign trade, furnishing convincing proof that the improvement was not in advance of the actual need. The reclamation of the flats at South Boston has proceeded to an extent already productive of much improvement in the channels and anchorage-ground of the harbor, by the dredging done in filling the twenty-five-acre parcel for the State, and in the partial filling of the fifty acres for the Boston and Albany Railroad Company. The Board anticipate still greater benefit from the reclamation of the flats of the Commonwealth east of those of the railroad company and from the dredging which such reclamation will occasion. The care by a separate Board of the property interest of the State in the lands to be reclaimed has not resulted in any conflict of policy or measures. Concentrated attention to the pecuniary results of the improvement in progress is essential to final success.

The active co-operation of the State has been of great service in obtaining liberal action from the general government, which has appropriated $1,245,170 since the establishment of the Board of Harbor Commissioners in 1866, for works of improvement in Boston Harbor planned by that Board. A plan illustrating the dredging in the upper harbor by the State and general government will be found in the Appendix. The action of the United States in protecting the islands of the outer harbor could not have been delayed many years without serious consequences. The difficult scientific questions involved in wise regulation and supervision of harbor interests have received the continuous attention of engineers of ripe experience in the special studies required. Much information has been gathered and preserved that will be of use in future studies beyond any present means of measurement. No money expended by the Board has in its judgment brought greater returns than that expended for the service of scientific experts. The work of the Board could never be well done without a considerable expenditure for service of this nature, but some of that which will be necessary will be more properly chargeable to the special fund of the harbor in relation to which it may be required.

Received from Tide-Lands.

There has been received during the year, from the sale of flats belonging to the Commonwealth required for the extension of structures in tide-water licensed by the Board, the sum of $11,116.55. This amount does not go to the credit of the compensation-fund, but to the sinking-fund for the redemption of the war-debt. The sum thus secured to the State so far amounts to $36,349.96.

Harbor Improvements by the General Government.

The improvements in the harbors of the Commonwealth during the year by the general government have embraced works in the harbors of Boston, Newburyport, Plymouth, Provincetown, Wareham, and Fall River, also in Taunton River. By the courtesy of Gen. George Thom and Gen. G. K. Warren, the Board are permitted to present extracts from the official reports concerning these works made to the chief engineer of the army, which will be found in the Appendix.

The substantial completion of the removal of sunken rock from the main channel in Boston Harbor is a great gain to the safety and convenience of the entrance. The removal of Man-of-war Shoal is under contract, and one-half the work executed. This Board has long deemed the removal of this shoal important, and in 1877 presented to Congress a memorial urging the action which has been taken.

Office and Field Work.

In addition to the usual routine work connected with the ordinary duties of the Board, the re-survey of Boston Harbor has continued to receive considerable time and attention from the engineers. The number of licenses granted during the year has been about the same as in previous years, a list of which is given below. Fewer controversies have arisen in relation to structures authorized than heretofore.

Plans approved by the Board of Harbor Commissioners during the year 1877, *for the erection of structures in or over tide-water, and licenses granted for such structures.*

Nos.

407. Boston and Hingham Steamboat Company, for leave to extend its wharf in Hingham Harbor on piles. Approved March 20, 1878.
408. Onset Bay Grove Association, for leave to build a pile wharf in Onset Bay, town of Wareham. Approved Feb. 27, 1878.
409. City of Boston, for leave to rebuild the southerly draw-pier of Cambridge Street Bridge over Charles River. Approved March 6, 1878.
410. Nathaniel E. Atwood of Provincetown, for leave to extend his wharf in Provincetown Harbor on piles. Approved March 6, 1878.

411. J. F. Small of Provincetown, for leave to build a pile wharf in Provincetown Harbor. Approved March 20, 1878.

412. Benjamin Lancy of Provincetown, for leave to extend his wharf in Provincetown Harbor on piles. Approved March 20, 1878.

413. R. G. Tarrant of Provincetown, for leave to construct a pile wharf in Provincetown Harbor. Approved March 20, 1878.

414. Boston and Hingham Steamboat Company, for leave to construct a pile wharf on Weir River at Nantasket Beach in the town of Hull. Approved March 20, 1878.

415. City of Boston, for leave to build a foundation for an office and stable on piles, for Meridian Street Bridge. Approved March 27, 1878.

416. City of Salem, for leave to widen and repair the draw in Essex Bridge over the river between Salem and Beverly. Approved April 3, 1878.

417. Stone & Downer, for the construction of a breakwater at Nye's Neck, near the entrance of Wild Harbor, town of Falmouth. Approved April 3, 1878.

418. Boston and Lowell Railroad Corporation, for leave to widen its freight-bridge over Charles River. Approved April 17, 1878.

419. Fitchburg Railroad Company, for leave to widen its bridge over Charles River on the north side. Approved April 24, 1878.

420. Fitchburg Railroad Company, for leave to widen the northerly pier of Constitution Wharf on piles. Approved April 24, 1878.

421. T. A. Newhall of Lynn, for leave to extend his wharf in Lynn Harbor by solid filling. Approved May 22, 1878.

422. Boston, Clinton, Fitchburg, and New Bedford Railroad Company, for leave to extend its wharf in New Bedford Harbor. Approved May 22, 1878.

423. Boston, Revere Beach, and Lynn Railroad Company, for the construction of a pile wharf and ferry-slip between Rowe's and Foster's Wharves, Boston. Approved May 22, 1878.

424. Boston, Revere Beach, and Lynn Railroad Company, for the construction of a pile wharf and ferry-slip at East Boston. Approved May 22, 1878.

425. Alden Choate of Lynn, and Jonathan Blaney and others of Swampscot, for leave to extend their wharf by solid filling, and dredge a channel in front of said wharf, in Lynn Harbor. Approved May 29, 1878.

426. Fenno Tudor of Nahant, for the extension of Central Wharf on piles in the town of Nahant. Approved May 29, 1878.

427. Boston and Albany Railroad Company, for leave to rebuild the draw in its bridge over Chelsea Creek. Approved May 29, 1878.

428. Town of Revere, for leave to fill solid Boatfield Bridge across Sales Creek. Approved June 19, 1878.

429. New York and New England Railroad Company, for leave to widen its bridge across Fort Point Channel, and fill up a dock between its property and what was formerly Drake's Wharf. Approved July 10, 1878.

430. Haskins Brothers, for the extension of their wharf on Maverick Street, East Boston. Approved July 17, 1878.

431. City of Cambridge, for leave to construct a retaining-wall on the easterly abutment of River Street Bridge. Approved July 1, 1878.

432. Samuel Q. Currier, for leave to build a sea-wall in Hingham Bay, town of Hull. Approved Sept. 4, 1878.

433. Kidder, Vaughan, & Co., for leave to build a wharf, partly solid and partly on piles, in Chelsea Creek, East Boston. Approved Sept. 11, 1878.

434. Daniel B. Gardner and others, for leave to construct a dam across the mouth of Juniper Point Cove, Salem Harbor. Approved Oct. 30, 1878.

435. Maverick Oil Company, for leave to fill flats, and enclose the same by a sea-wall, in Chelsea Creek, East Boston. Approved Sept. 25, 1878.

436. Nehemiah Lee, for leave to extend his wharf and excavate a channel therefrom, in Lynn Harbor. Approved Oct. 2, 1878.

437. Eben Wright, for the construction of a solid wharf at Cohasset Narrows in the town of Sandwich. Approved Oct. 9, 1878.

438. Plans and specifications for the construction of platforms in Fort Point Channel and the State Dock at South Boston, and for fenders upon heavy sea-walls upon the Harbor. Approved Aug. 30, 1878.

439. The same.

440. The same.

441. Andrew C. Wheelwright, for the construction of a pile-wharf in Cohasset Harbor. Approved Oct. 17, 1878.

442. J. W. White, for leave to build a stone wall and wharf in Marblehead Harbor. Approved Oct. 17, 1878.

443. Mercantile and Commercial Wharf Corporations, for leave to drive piles between their piers for the foundation of storehouses. Approved Oct. 23, 1878.

280. Boston, Revere Beach, and Lynn Railroad Company, for leave to fill solid the bridges on the line of its location between its depot at Lynn and Saugus River. Approved Oct. 23, 1878.

444. Central Wharf and Wet Dock Corporation, for leave to widen its wharf in Boston Harbor. Approved Oct. 30, 1878.

445. Stephen N. Breed, for leave to fill up a portion of his dock in Lynn Harbor. Approved Nov. 6, 1878.

446. George H. and John Cavanagh, for leave to build a road from Dorchester Avenue to "Wales Island," South Bay. Approved Nov. 6, 1878.

447. Hiram Harding and others, for leave to build a pile wharf at Stage Harbor, Chatham. Approved Nov. 6, 1878.

448. David P. Davis, for leave to extend his wharf on piles in Taunton River, town of Somerset. Approved Nov. 13, 1878.

449. Mount Hope Iron Company of Somerset, for the extension of their wharf by solid filling in Taunton River. Approved Nov. 20, 1878.

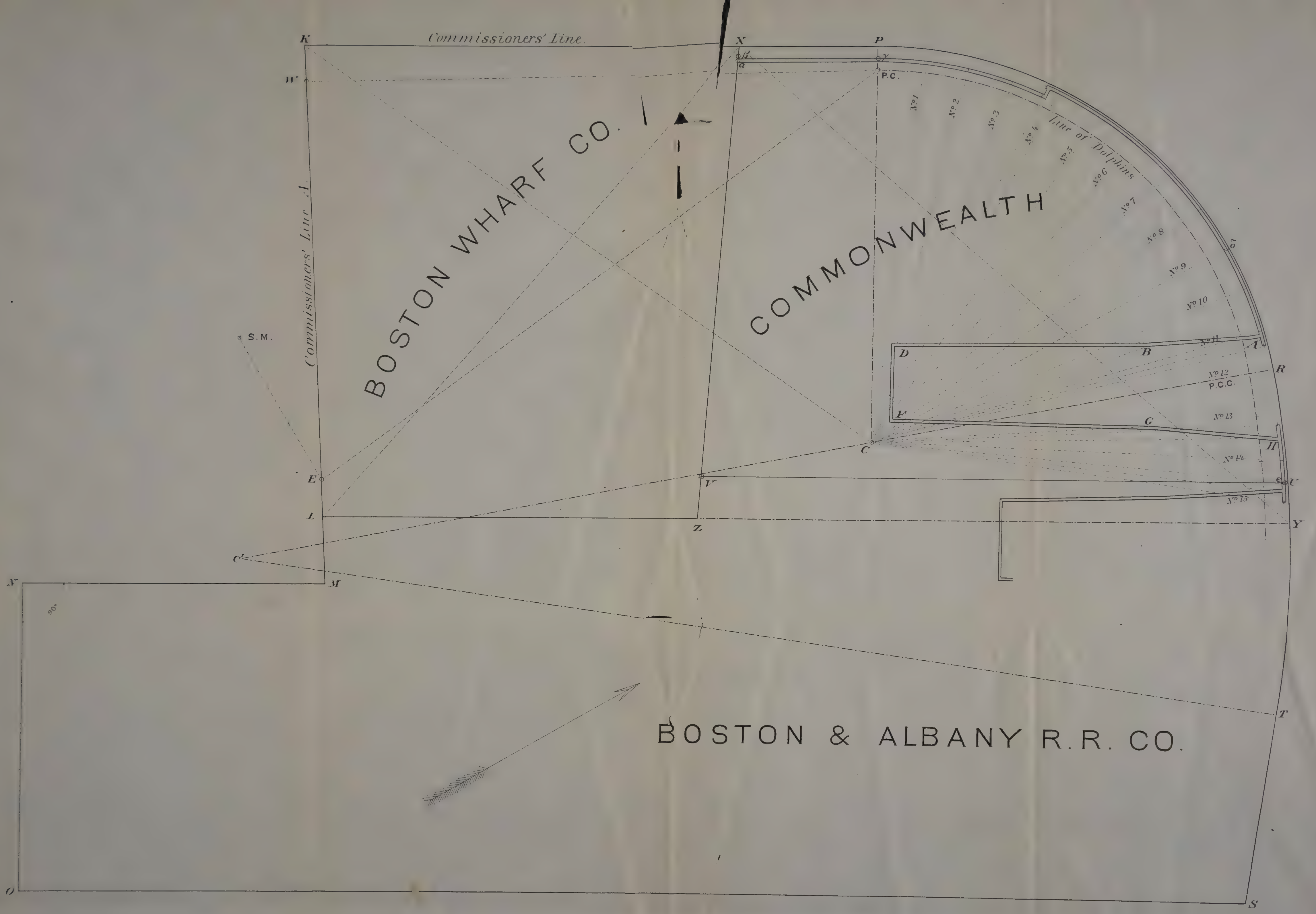
450. Fitchburg Railroad Company, for leave to straighten the end of Constitution Wharf, Boston Harbor. Approved Dec. 4, 1878.

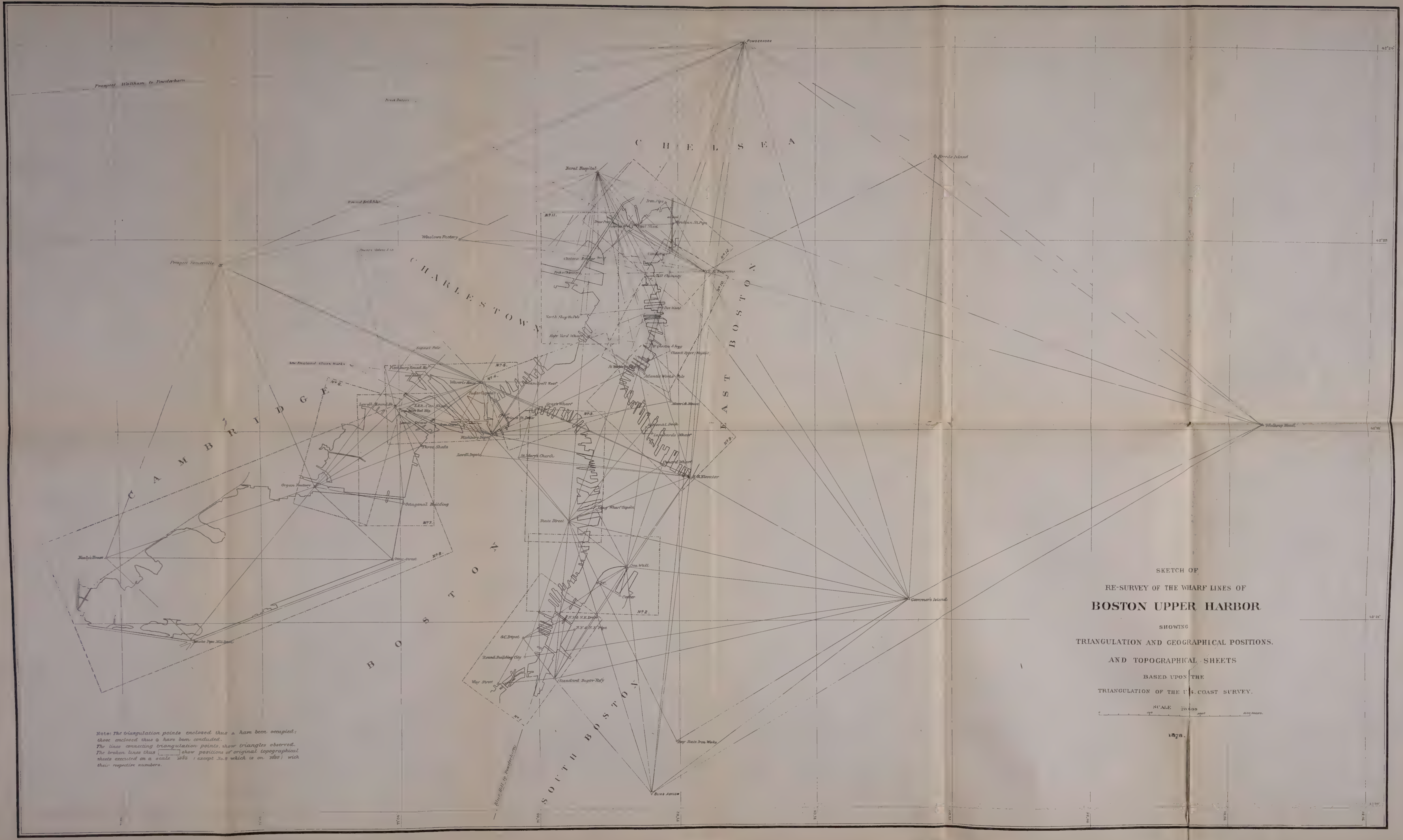
The Board continues under obligations to Hon. C. P. Patterson, Superintendent of the United States Coast Survey, and to Generals Thom and Warren of the Engineer Department, for courteous assistance given in their work.

During the year Professor Peirce and Professor Mitchell have resigned their positions as members of the United States Advisory Council. The Board has been much indebted to these officers in the past; and, although Professor Peirce has been less frequently consulted for the latter portion of his service, the privilege of obtaining his opinion when needed was highly esteemed. Professor Mitchell's duties on the United States Coast Survey enabled him to be with the Board a larger portion of his time than any other member of the Advisory Council could give to the work; and the Board has derived from his service assistance of very great value. It is hoped that as future occasion shall arise, the Board will be able to obtain again the counsel and assistance of these eminent authorities. Professor Henry L. Whiting of the United States Coast Survey has continued to render the Board valuable service.

FREDERIC W. LINCOLN.
FRANCIS A. NYE.
ALBERT MASON.

BOSTON, Dec. 30, 1878.


Commissioners' Line.
K
X
P
W
β
γ
α
P.C.
No 1
No 2
No 3
No 4
No 5
No 6
No 7
No 8
No 9
No 10
No 11
No 12
P.C.C.
No 13
No 14
No 15
Line of Dolphins
BOSTON WHARF CO.
COMMONWEALTH
Commissioners' Line A.
S.M.
D
B
A
R
F
G
H
C
E
V
U
L
Z
Y
C'
N
M
90°
T
BOSTON & ALBANY R.R. CO.
O
S



SKETCH OF

RE-SURVEY OF THE WHARF LINES OF

BOSTON UPPER HARBOR

SHOWING

TRIANGULATION AND GEOGRAPHICAL POSITIONS.

AND TOPOGRAPHICAL SHEETS

BASED UPON THE

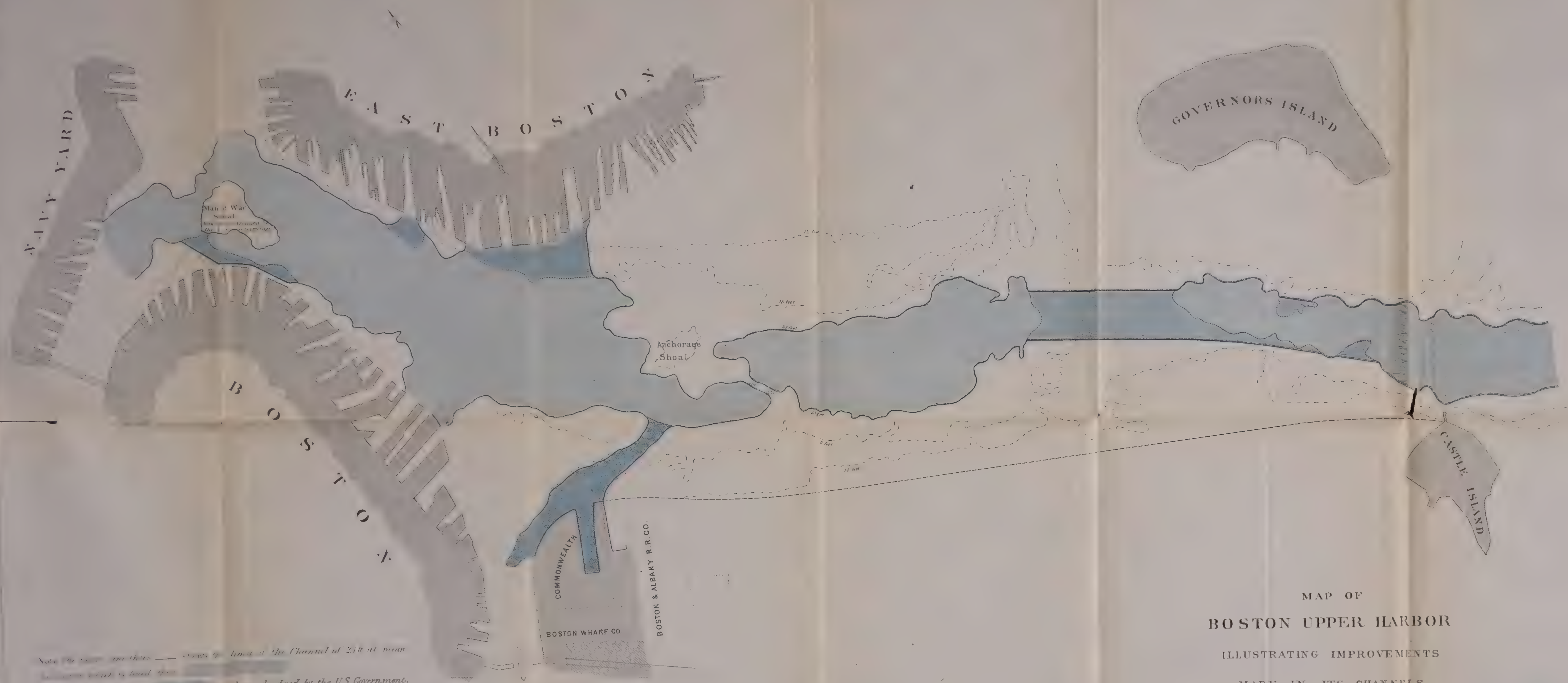
TRIANGULATION OF THE U.S. COAST SURVEY.

SCALE $\frac{1}{20\,000}$

1600 Meters.

1878.

Note: The triangulation points enclosed thus ▲ have been occupied; those enclosed thus ◉ have been concluded.
The lines connecting triangulation points, show triangles observed.
The broken lines thus ⬚ show positions of original topographical sheets executed on a scale $\frac{1}{1000}$ (except No. 8 which is on $\frac{1}{5000}$) with their respective numbers.



Note. The [illegible] shows the limit of the Channel of 23 ft at mean low water [illegible] [illegible] been dredged by the U.S. Government. [illegible] Commonwealth of Massachusetts to [illegible]

" " " 18 " " " " " "

MAP OF

BOSTON UPPER HARBOR

ILLUSTRATING IMPROVEMENTS

MADE IN ITS CHANNELS.

1878.

SCALE 1/10 000

APPENDIX.

[A.]

IMPROVEMENT OF SOUTH BOSTON FLATS.

RECORD OF POINTS AND LINES DEFINING THE "TWENTY-FIVE-ACRE PIECE," IMPROVED BY THE STATE IN 1873-7, AND ADJOINING FLATS.

MAY, 1878.

TABLE I.

POINT.	Ordinate.	Abscissa.	Angle at C right from P to point.			Angle at P C left from C to point.			Angle at C right from δ to point.			Angle at δ left from C to point.			Distance from C to point.	Angle at C′ right from C to point.			Distance from C′ to point.
	Feet.	Feet.	°	′	″	°	′	″	°	′	″	°	′	″	Feet.	°	′	″	Feet.
P	0.	0.		–			–			–			–		–		–		–
PC	0.	50.		–			–			–			–		–		–		–
C	0.	910.		–			–			–			–		–		–		–
R	+ 893.334	736.641		–			–			–			–		–		–		–
Y	+ 934.823	1092.890		–			–			–			–		–		–		–
T	+ 911.565	1532.609		–			–			–			–		–		–		–
S	+ 848.043	1964.968		–			–			–			–		–		–		–
O	− 1932.380	1962.391		–			–			–			–		–		–		–
N	− 1932.380	1248.391		–			–			–			–		–		–		–
M	− 1247.380	1248.391		–			–			–			–		–		–		–
L	− 1253.970	1092.030		–			–			–			–		–		–		–
K	− 1300.000	0.		–			–			–			–		–		–		–
X	− 312.500	0.		–			–			–			–		–		–		–
Z	− 396.079	1089.801		–			–			–			–		–		–		–
U	+ 929.062	997.548		–			–			–			–		–		–		–
V	− 388.768	994.471		–			–			–			–		–		–		–
C′	− 1433.262	1188.135		–			–			–			–		–		–		–
α	− 314.782	29.800		–			–			–			–		–		–		–
β	− 314.642	27.976		–			–			–			–		–		–		–
γ	0.	29.800		–			–			–			–		–		–		–
A	+ 870.295	667.146	74	24	30	54	39	31.25		–			–		903.544		–		–
B	+ 616.407	683.359	69	48	45	44	13	22.5		–			–		656.753		–		–
D	+ 48.874	687.659	12	23	50		–			–			–		227.65 ...		–		–
F	+ 45.714	860.133	42	30	45		–			–			–		67.65 ...		–		–
G	+ 615.813	868.408	86	08	10	36	57	35		–			–		617.216		–		–
H	+ 912.133	892.685	88	54	45		–		28	56	57.5	76	09	17.5	912.298		–		–
ε	+ 925.387	997.540	95	24	00		–		35	26	12.5	74	27	55	929.512		–		–

Front Top Line of Caps — opposite Dolphin No. 1	+102.335	33.892	6 39 44.3	–	–	–	882.064	–	–
Front Top Line of Caps — opposite Dolphin No. 2	+203.345	51.439	13 19 28.6	–	–	–	882.313	–	–
Front Top Line of Caps — opposite Dolphin No. 3	+301.626	80.728	19 59 15.1	–	–	–	882.423	–	–
Corner in Front Top Line of Caps — Spur in Fort Point Channel Light Wall	+371.073	110.555	24 53 56.4	80 43 55	–	–	881.367	–	–
Front Top Line of Caps — West End of Heavy Wall West of Dock	+381.797	84.945	24 49 57	–	–	–	909.112	–	–
Front Top Line of Caps — opposite Dolphin No. 4	+407.664	97.656	26 38 57.1	–	–	–	908.897	–	–
Front Top Line of Caps — opposite Dolphin No. 5	+499.137	150.469	33 18 41.4	–	–	–	908.859	–	–
Front Top Line of Caps — opposite Dolphin No. 6	+583.940	213.419	39 58 22.5	–	–	–	908.961	–	–
Front Top Line of Caps — opposite Dolphin No. 7	+660.684	286.095	46 38 24	–	–	–	908.714	–	–
Front Top Line of Caps — opposite Dolphin No. 8	+728.337	367.032	53 17 45	–	–	–	908.454	–	–
Front Top Line of Caps — opposite Dolphin No. 9	+786.611	455.176	59 57 47.5	–	–	–	908.637	–	–
δ	+785.312	455.927	59 57 47.5	62 39 56.25	–	–	907.137	–	–
Front Top Line of Caps — opposite Dolphin No. 10	+834.250	549.468	66 37 40	–	–	–	908.821	–	–
Front Top Line of Caps — opposite Dolphin No. 11	+870.289	648.671	73 17 10	–	–	–	908.678	–	–
Front Top Line of Caps — East End of Heavy Wall West of Dock	+879.222	681.754	75 26 50	–	–	–	908.365	–	–
1.5 feet back from Front Top Line of Caps — West end of Heavy Wall East of Dock	+912.034	865.992	87 14 15	–	27 16 27.5	77 08 08.75	913.095	3 09 40.2	2367.317
1.5 feet back from Front Top Line of Caps — nearly opposite Dolphin No. 14	+921.802	945.761	92 13 18	–	32 15 30.5	75 32 00	922.495	5 06 22.4	2367.503

TABLE I. — Concluded.

POINT.	Ordinate.	Abscissa.	Angle at C right from P to point.	Angle at PC left from C to point.	Angle at C right from δ to point.	Angle at δ left from C to point.	Distance from C to point.	Angle at C′ right from C to point.	Distance from C′ to point.
	Feet.	Feet.	° ′ ″	° ′ ″	° ′ ″	° ′ ″	Feet.	° ′ ″	Feet.
1.5 feet back from Front Top Line of Caps — East End of Heavy Wall East of Dock	+929.490	1043.620	98 10 50	–	38 13 02.5	73 44 50	939.045	7 28 55.5	2367.167
Intersection of Front Top Line of Caps of B. & A. Dock Wall with Back Top Line of Heavy Wall East of Dock	+924.442	1016.837	96 35 32.5	–	36 37 45	73 53 37.5	930.594	6 30 03.5	2363.918

Rectangular Coördinates. — Ordinates are from line through origin and centre of curve of 910 feet radius, and are marked + when northerly and — when southerly.

Abscissas are easterly from tangent in Commissioners' line at origin of coördinates.

TABLE. II.

LINE.	LENGTH OF		Angle between line or chord and Commissioners' line tangent at P.	S.	C.	Radius.	Angle at Centre.
	Line or Arc. Feet.	Chord. Feet.		Feet.	Feet.	Feet.	
			° ′ ″				° ′ ″
P-R . . .	(1) 1,255.	1,157.80	38 – 30 – 32.05	736.641	893.334	(1) 910.	79 – 01 – 04.10
PC-PCC . .	1,186.044	–	do.	–	–	860.	do.
P-Y . . .	(1) 1,614.	–	–	–	–	–	–
R-T . . .	(1) 800.	796.207	88 – 41 – 16.71	795.968	18.231	(1) 2,370.	19 – 20 – 25.23
Y-S . . .	(3) 878.	–	–	–	–	–	–
R-Y . . .	359.	358.657	83 – 21 – 26.27	356.249	41.488	(1) 2,370.	8 – 40 – 44.33
T-S . . .	437.	–	98 – 21 – 29.33	432.358	63.522	–	–
S-O . . .	2,780.484	–	–	2.574	2,780.483	–	–
O-N . . .	(3) 714.	–	(3) 90	714.	0.	–	–
N-M . . .	(3) 685.	–	(3) 0	0.	685.	–	–
M-L . . .	(3) 156.5	–	87 – 35 – 11	156.361	6.591	–	–
L-K . . .	(2) 1,093.	–	do.	1,092.030	46.029	–	–
P-K . . .	(1) 1,300.	–	0	0.	1,300.	–	–
K-X . . .	987.5	–	0	0.	987.5	–	–
X-P . . .	(2) 312.5	–	0	0.	312.5	–	–
X-L . . .	1,441.874	–	130 – 46 – 02	1,092.033	941.523	–	–
X-Y . . .	1,658.379	–	41 – 13 – 28.05	1,092.890	1,247.323	–	–
Z-L . . .	(2) 858.	–	–	2.229	857.892	–	–
X-Z . . .	(2) 1,093.	–	94 – 22 – 48	1,089.801	83.579	–	–
X-V . . .	997.390	–	do.	994.471	76.268	–	–
Y-Z . . .	1,330.906	–	0 – 07 – 58.5	3.088	1,330.902	–	–
R-U . . .	263.477	263.380	–	–	–	(1) 2,370.	6 – 22 – 10.5
U-V . . .	1,317.830	–	0 – 07 – 58.5	3.076	1,317.830	–	–
V-Z . . .	95.610	–	94 – 22 – 48	95.330	7.310	–	–
P-PC . . .	50.	–	90	50.	0.	–	–
PC-C . . .	860.	–	90	860.	0.	–	–
R-C′ . . .	(1) 2,370.	–	169 – 01 – 04.10	451.494	2,326.597	–	–
K-W . . .	83.8	–	87 – 35 – 11	–	–	–	–
W-E . . .	922.	–	do.	–	–	–	–

TABLE II. — Continued.

LINE.	LENGTH OF		Angle between line or chord and Commissioners' line tangent at P.	S.	C.	Radius,	Angle at Centre.
	Line or Arc. Feet.	Chord. Feet.		Feet.	Feet.	Feet.	
			° ′ ″				
K–C . . .	1,586.852	–	–	910.	1,300.		–
A–B . . .	254.405	–	–	16.213	253.888		–
B–D . . .	567.549	–	–	4.300	567.533		–
D–F . . .	172,503	–	–	172.474	3,160	–	–
F–G . . .	570.158	–	–	8.275	570.099	–	–
G–H . . .	297.313	–	–	24.277	296.320	–	–
E–L . . .	87.2	–	87 – 35 – 11	–	–	–	–
SM–E . . .	380.14	–	63 – 01 – 04	–	–	–	–

Angle C–PC–W = 88° 30′ 22″
" PC–W–E = 89° 04′ 49″

S = product of length of line by the sine of the angle made by it with the Commissioners' line tangent at P.
C = product of length of line by the cosine of the angle made by it with the Commissioners' line tangent at P.

(1) See Second Report of Harbor Commissioners, p. 8.
(2) See Fourth Report of Harbor Commissioners, p. 70.
(3) See Fourth Report of Harbor Commissioners, p. 100.

DESCRIPTION OF POINTS IN TABLES.

α Copper bolt on Boston Wharf Company's line, in top of most southerly cap of Fort Point Channel light wall, 1.7 feet back from front, and about 0.4 feet from south side of said cap.

β Copper bolt on Boston Wharf Company's line, in second face-stone under most southerly cap of Fort Point Channel light wall, and 1.83 feet out from *α*.

γ Copper bolt 2.15 feet back from front top line of caps of Fort Point Channel light wall, at south end of curve.

δ Copper bolt 1.5 feet back from front top line of caps of heavy wall west of dock, and 557.2 feet from west end of said wall, in range with No. 9 dolphin and C.

ε Copper bolt 2.5 feet back from front top line of caps of heavy wall east of dock, 46.12 feet from east end of said wall. This bolt is on Boston and Albany Railroad Company's line, provided a strip 95.33 feet in width (containing 126,280 square feet) is set off to said company from old boundary, as proposed.

V Copper bolt in the top of stone monument 8 inches square, set 5 feet in the ground. It is on the line of the Boston Wharf Company, and is on the line of the Boston and Albany Railroad Company also, provided a strip 95.33 feet in width (containing 126,280 square feet) is set off as proposed.

C Copper tack in the top of a wooden post 6 inches square, set 8 feet in the ground. It is at the centre of the curve of 910 feet radius in the Commissioners' line, and is 67.75 feet from south-east corner of State dock-wall.

C′ Centre of curve of 2,370 feet radius, not fixed on the ground.

PC Copper tack in the top of a wooden post 6 inches square, set four feet in the ground. It is at the P.C. (beginning) of curve of 860 feet radius, and 22.35 feet back from front top line of caps of Fort Point Channel light wall.

E Copper tack in the top of a pile of an old bulkhead on Commissioners' line A.* It is 87.2 feet westerly from L.

W Copper tack in the top of an oak plug about 15 inches long, driven into the ground flush with its top. It is 922 feet from E on Commissioners' line A,* and about 80.3 feet from front of wooden wharf, and about in range with the top front line of a jog of 10 feet in Channel wall.

R Tangent point of both the curve of 910 feet radius and the curve of 2,370 feet radius in the Commissioners' line.

U Intersection of the line through *ε* and V with the Commissioners' line.

Y Original north-east corner of the "twenty-five-acre piece" of State flats before setting off a strip from it to the Boston and Albany Railroad Company.

T East end of the curve of 2,370 feet radius in the Commissioners' line.

Z North-east corner of the Boston Wharf Company's flats and the original south-east corner of the "twenty-five-acre piece" of State flats.

X South-west corner of the "twenty-five-acre piece," and north-west corner of the Boston Wharf Company's flats. On Commissioners' line along Fort Point Channel.

K Intersection of Commissioners' line A* with the Commissioners' line on the east side of Fort Point Channel.

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* Commissioners' line A as fixed on ground by Harbor Commissioners in 1873.

SM Point 0.29 feet south and 0.04 feet east of a copper bolt in stone monument. It is on the range of the west side of A Street in South Boston, and is 380.14 feet from E.

P Origin of co-ordinates and beginning of curve of 910 feet radius in Comsioners' line.

*A Intersection of the back † top line of caps of the heavy wall west of dock with the prolongation of the front top line of caps of the straight part of the west dock-wall between the angle point and the heavy wall.

*B Front top line of caps at the angle point in the west dock-wall.

D Intersection of the front top line of caps of the west dock-wall with the front top line of caps of the end dock-wall.

F Intersection of the front top line of caps of the end dock-wall with the front top line of caps of the east dock-wall.

*G Front top line of caps at the angle point in the east dock-wall.

*H Intersection of the front top line of caps of the east dock-wall with the back † top line of caps of the heavy wall east of dock.

See accompanying sketch for location of points in tables.

Measurements were made with a steel tape, and were corrected for temperature, &c., so as to agree with the Boston City Hall standard.

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* Marked by crowfoot (↑) cut in wall.

† Back top line of caps of heavy wall is 5 feet back from front line.

[B.]

REPORT ON TRIANGULATION CONNECTED WITH THE RE-SURVEY OF BOSTON UPPER HARBOR FOR THE MASSACHUSETTS BOARD OF HARBOR COMMISSIONERS. 1877–78.

BY **FRANCIS BLAKE**, JUN., ASSISTANT U.S. COAST SURVEY.

BOSTON, MASS., March, 1878.

MR. C. P. PATTERSON, *Superintendent United States Coast Survey.*

Sir, — By an Act of the Massachusetts Legislature of 1877, an appropriation for the re-survey of Boston Upper Harbor was made, to be expended under the direction of the honorable Board of Harbor Commissioners of the Commonwealth.

In September last, in response to a request of the Board, you were pleased to instruct me to execute the triangulation connected with this re-survey; and I now have the honor of making a final report on its execution, and of transmitting to you its records, computations, and final results.

Your instructions, dated Tuesday, Sept. 11, 1877, were received the following Thursday; and the next day I placed my services at the disposal of the Board. They expressed the wish that I should at once begin such a triangulation as would establish a large number of initial points for the topographical survey, and assigned Messrs. William E. McClintock and H. Raeder to act as my assistant and recorder, respectively, during the work. Mr. McClintock had already been engaged for several weeks in erecting signals, and searching for some old established Coast Survey points from which the triangulation might be started. In this search he had succeeded in identifying but one point in the vicinity of our work, which had been occupied during the original triangulation of the harbor. This point was Blind Asylum Cupola, South Boston; and a reference to the old scheme showed that a line thence to Powderhorn Chelsea, would best serve as a base from which to start our work. But all traces of the latter station had been obliterated during the construction of a road across the summit of the hill from which it derives its name. Arrangements were made, therefore, to determine at once a new station on Powderhorn Hill from the old Coast Survey base, Blue Hill to Prospect Waltham. Tripod signals were erected at the points of this main triangle; but, by the time we received a suitable instrument for the angular measurements, the smoke of the city, which had been rapidly increasing with the advance of the season, had become so dense, that, even on the clearest days, the signals were not well enough defined to be observed upon. However, Mr. McClintock, with commendable ingenuity and at a trifling expense, devised and constructed two heliotropes, with the aid of which this first step in our work was brought to a satisfactory conclusion. About 150 measurements were made to determine the angle at each station; the probable errors of the finally adopted values being 0″.32 at Blue Hill, 0″.23 at Prospect Waltham, and 0″.46 at Powderhorn.

The following data with reference to the base, Blue Hill to Prospect Waltham, were promptly furnished, at my request, by Professor J. E. Hilgard, assistant in charge of the Coast Survey office: —

Blue Hill, Latitude 42° 12′ 41″.900. Longitude 71° 6′ 31″.630.
Prospect Waltham, Latitude 42° 23′ 16″.842. Longitude 71° 14′ 54″.393.
Blue Hill to Prospect Waltham, K = 22722.78 meters.
Blue Hill to Prospect Waltham, Z = 149° 35′ 57″.8.
Prospect Waltham, to Blue Hill, Z = 329° 30′ 19″.4.

These data, in connection with our observations, give the following geodetic position of Powderhorn (1877): —

Latitude 42° 24′ 2″.589.
Longitude 71° 1′ 30″.999.

The old established geodetic position of Blind Asylum, also furnished by Professor Hilgard, is: —

Latitude 42° 20′ 5″.055.
Longitude 71° 2′ 11″.795.

By working our L M Z formula backward, the length and azimuths of the line joining these points have been deduced as follows: —

Powderhorn (1877) to Blind Asylum, K = 7387.68 meters.
Powderhorn (1877) to Blind Asylum, Z = 7° 15′ 42″.7.
Blind Asylum to Powderhorn (1877), Z = 187° 15′ 15″.2.

This is the base from which the subsequent triangulation is derived.

It should be noted that the work up to this point was entirely unforeseen at the time the original estimate was made of the cost of the triangulation connected with the re-survey of the wharf lines of Boston Upper Harbor. [*Vide* "Eleventh Annual Report of the Board of Harbor Commissioners," p. 17.] It was then believed that the triangulation could be started directly from a base in the immediate vicinity of the work; but the impracticability of the plan, owing to the destruction of the old station-marks, has already been shown.

The above-mentioned base having been established, the subsidiary triangulation for the determination of topographical points was begun, and the field-work diligently prosecuted whenever the weather allowed. During the progress of this work, the idea occurred to me of carefully determining and permanently marking a number of points, without the city limits, so selected that the lines joining them should form a series of bases, from which any future changes in the harbor lines could be at once referred to the topographical survey. I therefore addressed the following letter to the Board : —

BOSTON, MASS., Oct. 23, 1877.

To the Honorable Board of Harbor Commissioners of the Commonwealth of Massachusetts.

GENTLEMEN, — I beg leave to call your attention to the importance of permanently marking a number of the principal stations occupied during the geodetic work upon which I am engaged under your direction. Many of the points determined are selected with special reference to aiding the topographer in his plane-table survey, and will cease to be of extraordinary value when that survey is finished. For these points a temporary marking — as a wooden stub with nail in centre — is therefore sufficient. But it seems to be of great importance that such a series of points should be permanently marked as will enable any future changes in the harbor-lines to be at once, at a trifling expense, referred to the survey now in progress. In selecting these points, due weight must be given to the probability of the land in their vicinity remaining undisturbed; and for marking them I would suggest granite posts, six inches square and five feet long, dressed six inches at the top, and a copper bolt inserted in drill-hole at centre. Such posts can be delivered at the different stations at an average cost of five dollars and fifty cents each. They should be set in the ground, with their tops six inches above the surface. There are not more than fifteen stations which should be so marked.

Very respectfully yours,

FRANCIS BLAKE, JUN., *Assistant U.S.C.S.*

At their next meeting, the Board were pleased to approve the plan proposed in the above letter, and further requested that the letters U.S.C.S. should be cut on the upper faces of the stone monuments mentioned therein.

Eight points were determined and marked in accordance with this approved plan. Their geodetic positions, — determined as directly as possible from the original base, Powderhorn (1877) to Blind Asylum, — and the corresponding lengths and azimuths of the connecting lines, which may be used as bases for future surveys, are given in the following tables.

STATION.	Latitude.			Longitude.		
	°	′	″	°	′	″
Winthrop Head	42	22	2.400	70	57	47.182
Breed's Island	42	23	26.070	71	0	9.218
Governor's Island	42	21	6.860	71	0	20.051
Powderhorn	42	24	2.589	71	1	30.999
East Boston Reservoir	42	22	50.579	71	1	48.835
South Boston Sea Wall	42	21	16.428	71	2	22.410
Naval Hospital	42	23	20.616	71	2	34 886
Prospect Somerville	42	22	52.639	71	5	16.856

BASE.	AZIMUTH.						Length of Base in Meters.
	Fore.			Back.			
	°	′	″	°	′	″	
Winthrop Head to Governor's Isl'd,	63	54	54.4	243	53	11.4	3,895.01
“ “ to E. B. Reservoir,	105	4	21.9	285	1	39.0	5,724 44
“ “ to Naval Hospital,	110	9	49.1	290	6	35.2	7,009.60
“ “ to Powderhorn .	125	56	19.4	305	53	48.5	6,321.16
“ “ to Breed's Island .	128	28	53 7	308	27	18.0	4,149.66
Breed's Island to Governor's Isl'd .	3	18	12.0	183	18	4.7	4,302.09
“ “ to E. B. Reservoir .	64	20	27 6	244	19	20.4	2,527.81
“ “ to Powderhorn .	121	4	20.2	301	3	25.1	2,183.19
Governor's Isl'd to S. B. Sea Wall .	96	1	41.9	276	0	19.5	2,815.54
“ “ to Naval Hospital .	143	13	55.7	323	12	24.8	5,152.23
“ “ to E. B. Reservoir,	147	36	10.0	327	35	10.2	3,790.23
“ “ to Powderhorn	163	20	30.1	343	19	42.3	5,659.37
Powderhorn to E. B. Reservoir .	10	24	25.8	190	24	13.8	2,258.63
“ to Naval Hospital .	48	27	16.2	228	26	33.1	1,952.35
“ to Prospect Som'ville,	67	20	43.6	247	18	11.3	5,598.05
E. B. Reservoir to Naval Hospital .	131	20	20.7	311	19	49.7	1,402.81
Naval Hospital to Prospect Somerville . . .	76	53	53.1	256	52	3.9	3,803.70

Reference to the computations accompanying this report will show that there are many subsidiary lines, connecting the permanent stations of the preceding tables with stations upon prominent buildings within the city, which may well be used as bases for future surveys, provided the buildings are not destroyed. Of such lines, the more important are those leading to State Street Block,[1] Fitchburg Depot, and Waverley House Charlestown.

The geodetic positions of these stations, and the lengths and azimuths of the bases derived from them, are given in the following tables : —

STATION.	Latitude.			Longitude.		
	°	′	″	°	′	″
State Street	42	21	31.660	71	2	47.056
Fitchburg Depot	42	21	58.386	71	3	20.584
Waverley House	42	22	15.579	71	3	25.378

BASE.	Azimuth.						Length of Base in Meters.
	Fore.			Back.			
	°	′	″	°	′	″	
State Street to Governor's Island .	282	48	1.0	102	49	40.0	3,449.83
" " to Powderhorn . .	200	28	44.9	20	29	36.2	4,970.92
" " to S. B. Sea Wall .	129	48	19.6	309	48	3.0	734.06
" " to Naval Hospital .	184	43	47.1	4	43	55.3	3,372.97
" " to Waverley House .	147	5	50.5	327	5	24.7	1,613.91
Fitchburg Depot to Powderhorn .	213	10	42.2	33	11	56.1	4,578.89
" " to Naval Hospital	202	23	7.7	22	23	38.5	2,743.82
" " to Waverley H'se,	168	17	57.8	348	17	54.6	541.69
Waverley House to Naval Hospital,	209	55	2.0	29	55	36.0	2,315.10
" " to Prospect Somerville . .	114	9	31.6	294	8	16.5	2,794.66

The preceding tables present, in a convenient form, the data necessary for any future extension of the harbor-survey, or for the ready reference to the Coast Survey triangulation of work done by the local engineers of many of the towns in the vicinity of Boston. Points in Cambridge, Somerville, Malden, Everett, Revere, Chelsea, Winthrop, Lynn, or Nahant, can be determined directly from one or more of the permanently marked bases. An exact description of the position of each station is given in the volume of the original records of the triangulation, labelled "Descriptions of Stations;" and a copy of this volume may be referred to at any time, on application to the engineer of the Board of Harbor Commissioners.

In the following tables the results of the triangulation are presented in the form which will best serve topographers in the execution of plane table surveys. The relative positions of all points are shown in the sketch of the triangulation appended to this report. Information as to the location of each point may be found in the volume of "Descriptions of Stations" above mentioned.[2]

[1] Written "State Street" in the records and computations.

[2] For additional tables, see end of this Report.

UNITED STATES COAST SURVEY — *Geographical Positions.*

NAME OF STATION.	Latitude.			DM.	Longitude.			DP.	Azimuth.			Back Azimuth.			TO STATION.	Distance.	Logarithms.
	°	′	″	Meters.	°	′	″	Meters.	°	′	″	°	′	″		Meters.	
Powderhorn (1877)	42	24	2.589	79.9	71	1	30.999	708.8	85	40	56.1	265	31	54.4	Prospect Waltham	18,426.69	4.2654473
									18	10	43.9	198	7	21.6	Blue Hill	22,100.29	4.3443980
Blind Asylum	42	20	5.055	156.0	71	2	11.795	270.0	187	15	15.2	7	15	42.7	Powderhorn (1877)	7,387.68	3.8685079
Winthrop Head (1877)	42	22	2.400	74.0	70	57	47.182	1079.5	125	56	19.4	305	53	48.5	Powderhorn (1877)	6,321.16	3.8007971
									59	9	5.0	239	6	6.7	Blind Asylum	7,055.23	3.8485112
Governor's Island (1877)	42	21	6.860	211.6	71	0	20.051	458.9	163	20	30.1	343	19	42.3	Powderhorn (1877)	5,659.37	3.7527678
									243	53	11.4	63	54	54.4	Winthrop Head (1877)	3,895.01	3.5905085
Breed's Island	42	23	26.070	804.3	71	0	9.218	210.8	3	18	12.0	183	18	4.7	Governor's Isl'd (1877)	4,302.09	3.6336794
									308	27	18.0	128	28	53.7	Winthrop Head (1877)	4,149.66	3.6180127
E. Boston Reservoir (1877)	42	22	50.579	1560.4	71	1	48.835	1117.3	5	52	33.5	185	52	18.0	Blind Asylum	5,133.72	3.7104325
									285	1	39.0	105	4	21.9	Winthrop Head (1877)	5,724.44	3.7577328
East Boston Elevator	42	21	45.617	1407.3	71	1	54.450	1246.1	187	13	53.1	7	14	8.9	Powderhorn (1877)	4,259.83	3.6293921
									264	44	51.0	84	47	37.6	Winthrop Head (1877)	5,680.97	3.7544223
Prospect Somerville	42	22	52.639	1623.9	71	5	16.856	385.6	247	18	11.3	67	20	43.6	Powderhorn (1877)	5,598.05	3.7480366
									294	2	42.0	114	4	58.4	East Boston Elevator	5,071.16	3.7051071
State Street	42	21	31.660	976.8	71	2	47.056	1076.9	200	28	44.9	20	29	36.2	Powderhorn (1877)	4,970.92	3.6964363
									282	48	1.0	102	49	40.0	Governor's Isl'd (1877)	3,449.83	3.5377974
Naval Hospital	42	23	20.616	636.0	71	2	34.886	797.9	354	59	35.8	174	59	51.4	Blind Asylum	6,056.56	3.7822260
									290	6	35.2	110	9	49.1	Winthrop Head (1877)	7,009.60	3.8456929
Fitchburg Depot	42	21	58.386	1801.2	71	3	20.584	471.1	213	10	42.2	33	11	56.1	Powderhorn (1877)	4,578.89	3.6607602
									281	17	50.2	101	18	48.2	East Boston Elevator	2,009.70	3.3031315

Lowell Round House . .	42	22	7.757	239.4	71	4	2.327	53.2	224	19	5.1	44	20	47.1	Powderhorn (1877) .	4,952.94	3.6948627
									283	7	46.1	103	9	12.3	East Boston Elevator.	3,004.44	3.4777642
Waverley House . . .	42	22	15.579	480.7	71	3	25.378	580.6	74	4	17.9	254	3	53.0	Lowell Round House.	879.02	2.9440006
									327	5	24.7	147	5	50.5	State Street . . .	1,613.91	3.2078805
Organ Factory . . .	42	21	42.466	1310.1	71	4	37.130	849.7	157	13	40.1	337	13	13.3	Prospect Somerville .	2,347.91	3.3706817
									238	5	53.0	58	6	41.3	Waverley House .	1,933.39	3.2863184
Nealy's House . . .	42	21	20.370	628.4	71	6	6.110	139.8	201	35	24.6	21	35	57 8	Prospect Somerville .	3,061.51	3.4859364
									251	28	41.2	71	29	41.2	Organ Factory . .	2,147.18	3.3318686
Otter Street	42	21	19.479	601.0	71	4	3.851	88.1	132	58	2.0	312	57	39.6	Organ Factory . .	1,040.58	3.0172756
									181	20	22.9	1	20	23.9	Lowell Round House.	1,490.00	3.1731876
South Boston Sea wall .	42	21	16.428	506.8	71	2	22.410	512.8	353	42	10.7	173	42	17.9	Blind Asylum . .	2,215.42	3.3454571
									276	0	19.5	96	1	41.9	Governor's Isl'd (1877)	2,815.54	3.4495615
Sugar Refinery . . .	42	20	42.018	1296.3	71	2	54.512	1247.8	215	0	19.6	35	1	0.1	East Boston Elevator.	2,395.77	3.3794446
									319	23	22.3	139	23	51.1	Blind Asylum . .	1,502.18	3.1767211
Gray's Wharf . . .	42	22	7.511	231.8	71	2	55.321	1265.7	64	1	41.7	244	1	24.7	Fitchburg Depot .	642.81	2.8080829
									109	53	58.9	289	53	38.6	Waverley House .	731.37	2.8641392
Prince Street Draw . .	42	22	5.813	179.4	71	3	14.856	239.9	29	44	56.9	209	44	53.0	Fitchburg Depot .	263.93	2.4214817
									141	22	1.7	321	21	54.6	Waverley House .	385.70	2.5862525
Gambrell Roof . . .	42	22	16.402	506.0	71	3	5.395	123.4	32	0	26.8	212	0	16.6	Fitchburg Depot .	655.45	2.8165425
									86	49	27.1	266	49	13.6	Waverley House .	457.94	2.6608097
Tudor Cupola . . .	42	22	13.003	401.2	71	3	18.760	429.2	5	16	34.8	185	16	33.6	Fitchburg Depot .	452.89	2.6559902
									117	40	45.6	297	40	41.1	Waverley House .	171.08	2.2331883
Fitchburg Round House .	42	22	21.448	661.7	71	3	48.969	1120.3	317	36	26.6	137	36	45.8	Fitchburg Depot .	963.35	2 9837826
									288	32	52.4	108	33	8.3	Waverley House .	569.16	2.7552312
Pole on red one-story building.	42	22	5.948	183.6	71	3	56.336	1288.9	285	54	56.2	105	55	20.3	Fitchburg Depot .	850.67	2.9297606
									247	14	9.9	67	14	30.8	Waverley House .	767.96	2.8853403

UNITED STATES COAST SURVEY — *Geographical Positions* — Continued.

NAME OF STATION.	Latitude.			DM.	Longitude.			DP.	Azimuth.			Back Azimuth.			TO STATION.	Distance.	Logarithms.
	°	′	″	Meters.	°	′	″	Meters.	°	′	″	°	′	″		Meters.	
Lowell Draw . . .	42	22	3.163	97.6	71	3	47.362	1083.6	283	31	17.8	103	31	35.8	Fitchburg Depot .	630.20	2.7994800
									232	41	54.6	52	42	9.4	Waverley House .	632.13	2.8008076
North-eastern Ventilator on Eastern R.R. Car Shed.	42	22	7.964	245.7	71	3	39.468	903.0	304	21	43.7	124	21	56.4	Fitchburg Depot .	523.50	2.7189170
									233	54	16.1	53	54	25.6	Waverley House .	398.81	2.6007703
Iron Crane, Eastern Railroad Bridge.	42	22	3.936	121.5	71	3	35.363	809.1	296	51	8.0	116	51	18.0	Fitchburg Depot .	379.09	2.5787429
									212	26	35.8	32	26	42.5	Waverley House .	425.63	2.6290324
New England Glass Works.	42	22	20.668	637.6	71	4	20.829	476.5	296	30	5.6	116	30	46.2	Fitchburg Depot .	1,540.29	3.1876025
									277	3	3.7	97	3	41.1	Waverley House .	1,278.15	3.1065811
Signal Pole, Eastern Railroad Freight, at Prison Point.	42	22	25.286	780.1	71	3	54.472	1246.2	294	13	33.7	114	13	53.3	Waverley House .	729.85	2.8632317
									18	22	44.3	198	22	39.0	Lowell Round House.	569 87	2.7557732
Powers, Melvin & Co.'s Elevator.	42	22	57.052	1,760.1	71	4	18.965	433.9	316	13	26.0	136	14	2.1	Waverley House .	1,771.95	3.2484506
									345	56	49.3	165	57	0.5	Lowell Round House.	1,567.73	3.1952726
Upper Gable of three sheds joined.	42	21	55.434	1,710.1	71	3	50.809	1162.8	145	16	45.2	325	16	37.4	Lowell Round House.	462.58	2.6651882
									69	19	9.5	249	18	38.3	Organ Factory . .	1,132.86	3.0541779
Finial on Octagonal Building, City.	42	21	35.382	1,091.5	71	3	57.964	1326.6	174	17	39.9	354	17	37.0	Lowell Round House.	1,003.88	3.0016830
									103	42	28.7	283	42	2.3	Organ Factory . .	922.45	2.9649426
Smoke-pipe on new two-story house, Mill-dam.	42	20	54.310	1,675.2	71	5	31.930	730.9	220	9	34.4	40	10	11.3	Organ Factory . .	1,944.23	3.2887481
									135	47	21.7	315	46	58.7	Nealy's House . .	1,121.71	3.0498812
Long Wharf Cupola . .	42	21	35.108	1,083.1	71	2	36.386	832.7	330	58	24 6	150	58	34.0	So. Boston Sea wall .	659.08	2.8189414
									66	27	8.6	246	27	1.4	State Street . . .	266.32	2.4254015

Cunard Wharf . . .	42	21	48.010	1,481.1	71	2	6.908	157.8	20	0	16.6	200	0	6.2	So. Boston Sea wall .	1,036.92	3.0157460
									61	13	46.1	241	13	19.0	State Street . . .	1,047.99	3.0203574
National Dock, corner brick building	42	22	0.956	29.5	71	2	12.491	285.8	9	22	55.7	189	22	49.0	So. Boston Sea wall .	1,392.41	3.1437684
									41	11	13.4	221	10	50.1	State Street . . .	1,201.02	3.0795485
Bay State Iron Works .	42	20	22.784	702.9	71	2	1.238	28.3	239	34	8.1	59	35	16.3	Governor's Isl'd (1877)	2,685.56	3.4290355
									153	44	27.7	333	43	56.8	State Street . . .	2,369.60	3.3746751
Ventilator on round building, city.	42	20	48.290	1,489.7	71	3	6.124	140.2	261	24	42.5	81	26	34.4	Governor's Isl'd (1877)	3,843.55	3.5847321
									198	3	35.0	18	3	47.8	State Street . . .	1,407.41	3.1484207
Peck's Chimney . . .	42	22	49.114	1,515.2	71	2	42.576	974.1	267	53	4.1	87	53	40.3	E. B. Reservoir (1877)	1,230.11	3.0899425
									190	15	25.5	10	15	30.7	Naval Hospital . .	987.58	2.9945739
Chelsea Bridge . . .	42	22	54.576	1,683.7	71	2	34.602	791.6	276	42	32.4	96	43	3.3	E. B. Reservoir (1877)	1,054.09	3.0228757
									179	32	5.4	359	32	5.2	Naval Hospital . .	803.30	2.9048779
Coal Shed, Chelsea . .	42	23	4.586	141.5	71	2	18.137	414.8	302	48	32.3	122	48	52.1	E. B. Reservoir (1877)	797.45	2.9017055
									50	38	32.0	230	38	20.9	Chelsea Bridge . .	487.09	2.6876052
Iron Pipe, Chelsea . .	42	23	12.086	372.9	71	2	5.031	115.1	330	49	22.9	150	49	33.8	E. B. Reservoir (1877)	759.91	2.8807604
									51	23	7.1	231	22	47.2	Chelsea Bridge . .	865.66	2.9373481
Winslow's Factory . .	42	23	0.237	7.3	71	3	32.898	752.5	235	22	57.0	55	24	19.2	Powderhorn (1877) .	3,387.05	3.5298218
									277	7	23.9	97	8	34.0	E. B. Reservoir (1877)	2,398.81	3.3799967
Malden Bridge . . .	42	23	9.422	290.7	71	3	52 436	1199.4	243	5	50.0	63	7	25.4	Powderhorn (1877) .	3,626.66	3.5595069
									281	36	23.5	101	37	46.8	E. B. Reservoir (1877)	2,886.21	3.4603276
Brick Factory . . .	42	23	43.140	1,330.9	71	3	51.824	1185.4	259	26	0.2	79	27	35.2	Powderhorn (1877) .	3,275.72	3.5153068
									299	57	2.0	119	58	24.9	E. B. Reservoir (1877)	3,246.78	3.5114524
Round brick building, Charlestown.	42	23	12.828	395.7	71	4	8 756	200.3	246	56	4.7	66	57	51.1	Powderhorn (1877) .	3,920.77	3.5933719
									282	5	27.4	102	7	1.7	E. B. Reservoir (1877)	3,273.09	3.5149585
St. Mary's Church, north spire, city.	42	21	52.836	1,630.0	71	3	8.632	197.5	209	8	43.0	29	9	48.8	Powderhorn (1877) .	4,583.95	3 6612399
									277	28	7.1	97	28	57.1	E. B. Elevator . .	1,711.83	3.2334615

UNITED STATES COAST SURVEY — *Geographical Positions* — Concluded.

NAME OF STATION.	Latitude.			DM.	Longitude.			DP.	Azimuth.			Back Azimuth.			TO STATION.	Distance.	Logarithms.
	°	′	″	Meters.	°	′	″	Meters.	°	′	″	°	′	″		Meters.	
Lowell Depot, flag-staff	42	21	51.828	1,598.9	71	3	26.056	596.3	275	12	54.3	95	13	56.0	E. B. Elevator	2,104.73	3.3231964
									304	53	11.4	124	53	37.7	State Street	1,087.78	3.0365401
"P.C." (South Boston Flats)	42	21	12.046	371.6	71	2	35.202	805.6	245	12	7.7	65	12	16.3	So. Boston Sea wall	322.45	2.5084602
									155	51	30.7	335	51	22.7	State Street	663.15	2.8216095
"C." South Boston Flats	42	21	7.762	239.5	71	2	25.310	579.2	193	56	17.1	13	56	19.1	So. Boston Sea wall	275.50	2.4401178
									120	16	38.6	300	16	31.9	"P.C." So. Boston Flats	262.11	2.4184912

The observations have all been made by Mr. McClintock and myself; and experience has shown that there is no sensible difference in our habits of observing. In the record-books the observations marked + were made by me; all not so marked were made by Mr. McClintock. It was our aim to make thirty-six measurements of each of the principal angles, dividing them into six sets, of six repetitions each, three direct and three reversed, the verniers always being read before reversal. Of the less important angles, twenty-four, eighteen, or twelve measurements were made.

At the beginning of the work the Coast Survey theodolite No. 12 was used. It is a repeating instrument, made by Gambey of Paris: its horizontal circle is six inches in diameter, and is graduated to be read to ten seconds of arc by two equidistant verniers. The superior construction of this instrument is well known; but, owing to its low telescopic power, it was not suitable for use on the longer lines of our work. Most of the angular measurements were made with a new theodolite, constructed for the Board, with special reference to the work, by Messrs. Buff & Berger of Boston. It is a repeating instrument, with a horizontal circle eight inches in diameter, graduated to be read to ten seconds of arc by two equidistant verniers; but it is easily read to five seconds by estimation. The object-glass has a clear aperture of an inch and a half, and a focal length of about eleven inches, which allows the telescope to be revolved in its bearings without making the wye standards of an unusual height.

There are two achromatic eye-pieces, the magnifying powers of which are thirty and twenty-two diameters. The one of lower power was used throughout the work. The intersection of the spider-lines is such that the vertical angles are of sixty degrees.

The angles of the main triangle, Blue Hill, Prospect Waltham, and Powderhorn, were measured with this instrument; and, when corrected for spherical excess, they "close" that triangle within forty-nine hundredths of a second of arc. Their probable errors, as computed by the method of least squares, are 0″.32 at Blue Hill; 0″.23 at Prospect Waltham; and 0″.46 at Powderhorn. These results have been given elsewhere in this report; but I repeat them here, as perhaps the best proof that can be given of the superior construction of the Buff & Berger theodolite.

That you may readily form an opinion as to the general accuracy of the triangulation, I respectfully call your attention to the close agreement of the lengths of such of its lines as are determined through different series of triangles from the original base, and to the results of an entirely independent test which was made a few weeks ago, after the field-work had been otherwise finished.

Mr. Edward S. Philbrick, engineer in charge of the enclosure and filling of what is known as the *twenty-five-acre piece* of South Boston Flats, in his report upon the completion of that improvement (Appendix A, Annual Report of Massachusetts Board of Harbor Commissioners, 1877), refers all the points and lines defining the same to a certain base-line, measured upon the flats by his assistant, Mr. Joseph O. Osgood. The connection of this line with our triangulation, through a triangle side removed nine steps from the original base, Blue Hill to Prospect Waltham, is the test above referred to.

The length of the South Boston Flats base-line, as measured by Mr. Osgood, is 860.00 feet. The following are his notes upon its measurement as prepared for the Harbor Commissioners' report : —

C. Copper tack in the top of a wooden post 6 inches square, set eight feet in the ground. It is at the centre of the curve of 910 feet radius in the Commissioners' line, and is 67.65 feet from south-east corner of State dock-wall.

P.C. Copper tack in the top of a wooden post 6 inches square, set 4 feet in the ground. It is at the P.C. (beginning) of curve of 860 feet radius, and 22.35 feet back from front top line of caps of Fort Point Channel light wall.

Standard of measurement used is the city standard 100 feet measurement, back of City Hall. Corrections made for temperature.

The length of this line C. to P.C., as determined from our triangulation, is 859.96 feet; differing but four-hundredths of a foot, or a trifle less than half an inch, from the length as measured by Mr. Osgood. The aggregate length of the lines of our work leading from Blue Hill, Prospect Waltham, to the South Boston Flats base-line, is about 62 miles.

The results embodied in this report are derived from two entirely independent computations of the original observations. These computations were made by Mr. McClintock and myself, and by careful comparison and revision were made to exactly agree.

The computations which accompany this report are my own, and the records are the original field-books of the triangulation. Mr. McClintock's computations accompany the carefully prepared duplicates of these records, together with a copy of this report; all of which I will hold until you are pleased to instruct me as to the disposition which shall be made of them.

During its progress, much interest in the work has been shown by local engineers in the vicinity of Boston. At Somerville the Coast Survey station was necessarily established upon a bluff which will probably be graded down some 18 or 20 feet during the next few years. We had not, therefore, regarded it as one of the permanent stations; but, when visiting it for the purpose of providing a temporary marking, we were requested by Mr. G. A. Kimball, city engineer, to furnish points of reference which would enable him to permanently mark the station. His request was complied with, and a substantial granite monument is now in position. Mr. Kimball assures us that this monument will be carefully reset whenever the grading is accomplished.

Mr. Thomas Doane, president Boston Society of Civil Engineers, under date of Nov. 17, 1877, made a written request that a number of points might be determined for the use of local engineers, in connection with the "three-point problem;" and his request was complied with so far as could be done without entailing additional expense upon the survey.

Following are the statistics of work done by my party : —

Stations occupied	23
Signals erected	23
Points determined	49
Angles measured	225
Triangles computed	89
Number of observations	5,868

The total cost of the triangulation to date is about $2,300.00.

The original records and computations transmitted to you herewith are : —

5 vols. original records of horizontal angles observations.
1 vol. computations of triangulation.
1 vol.[1] descriptions of stations.

While reference to the record-books will inform you of the exact amount of work executed by my assistant, Mr. William E. McClintock, I desire, in closing this report, to make a special acknowledgment of his valuable services. To the zeal and ability with which they have been rendered, the successful accomplishment of the triangulation is largely due.

Very respectfully yours,

FRANCIS BLAKE, Jun.,
Assistant United States Coast Survey.

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[1] This volume has yet to be finished by Mr. McClintock, under direction of the Board, and will be forwarded to you as soon as possible.

Geographical Positions determined during Topographical Survey of Boston Upper Harbor, by William E. McClintock.

STATION.	Latitude.	Longitude.	Distance.	Logarithms.	Azimuth.	Back Azimuth.	To Station.
	° ′ ″	° ′ ″	Meters.		° ′ ″	° ′ ″	
Old Colony Depot . . .	42 20 55.153	71 3 7.857	507.50	2.7054370	322 59 31.2	142 59 40.2	Sugar Refinery.
			1,229.84	3.0898481	237 44 10.4	57 44 41.0	Sea wall.
Way Street	42 20 43.276	71 3 22.152	633.81	2.8019587	273 30 28.3	93 30 46.9	Sugar Refinery.
			491.24	2.6912894	221 45 30.6	41 45 21.0	Old Colony Depot.
N.Y. & N.E. Draw . . .	42 21 0.980	71 2 48.521	600.87	2.7787822	13 11 14.4	193 11 10.1	Sugar Refinery.
			477.64	2.6791027	67 53 40.7	247 53 27.7	Old Colony Depot.
N Y. & N.E. Pipe . . .	42 20 56.812	71 2 43.775	518.36	2.7146323	28 17 42.5	208 17 35.3	Sugar Refinery.
			553.52	2.7431364	84 41 57.4	264 41 41.2	Old Colony Depot.
Maverick House	42 22 9.326	71 2 3.612	1,792.95	3.2535681	79 9 26.9	259 8 35.0	Fitchburg Depot.
			2,312.92	3.3641606	161 59 1.1	341 58 40.0	Naval Hospital.
Lombard's Wharf . . .	42 21 57.636	71 2 11.773	1,574.41	3.1971171	90 50 56.6	270 50 10.2	Fitchburg Depot.
			2,614.13	3.4173337	168 19 52.8	348 19 37.2	Naval Hospital.
Dye Wood	42 22 38.603	71 2 7.322	2,085.26	3.3191600	53 29 32.3	233 28 42.9	Fitchburg Depot.
			1,441.44	3.1587965	154 3 37.5	334 3 18.9	Naval Hospital.
			907.30	2.9577520	354 38 0.3	174 38 2.8	Maverick House.
Navy Yard Wharf . . .	42 22 29.965	71 2 37.970	1,011.57	3.0049959	309 0 39.9	129 1 3.1	Maverick House.
			750.04	2.8750802	249 10 54.9	69 11 15.6	Dye Wood.
S. W. Cor. Tall Chimney . .	42 22 48.768	71 2 10.572	854.00	2.9314589	47 12 36.8	227 12 18.3	Navy Yard.
			322.33	2.5083024	346 39 30.7	166 39 32.9	Dye Wood.
			578.22	2.7620972	108 4 12.3	288 3 55.4	Chelsea Bridge.
			1,129.10	3.0527337	150 29 24.2	330 29 8.3	Naval Hospital.

Church Spire, Horizontal Stripes, E. B.	42 22 25.327	71 2 2.882	1,962.28	3.2927605	64 56 47.2	244 55 54.8	Fitchburg Depot.
			1,856.28	3.2686425	156 46 23.4	336 46 1.8	Naval Hospital.
McQuesten & Fogg . . .	42 22 26.980	71 2 12.381	592 57	2.7727411	98 56 30.4	278 56 13.2	Navy Yard.
			376.82	2.5761299	197 53 3.9	17 53 6.3	Dye Wood.
Gable Atlantic Works . .	42 22 19.016	71 2 18.038	567.46	2.7539356	126 32 6.0	306 31 52.6	Navy Yard.
			652.16	2.8143529	202 4 43.2	22 4 50.4	Dye Wood.
Atlantic Works Pole . . .	42 22 16.602	71 2 12.893	706.45	2.8490797	125 42 25.9	305 42 9.0	Navy Yard.
			690.68	2.8392761	190 37 59.7	10 38 3.5	Dye Wood.
N. Ship Ho. Pole, Navy Yard .	42 22 36.930	71 2 41.476	783.02	2.8937727	266 12 58.9	86 13 21.9	Dye Wood.
			1,356.22	3.1323290	186 22 39.4	6 22 43.8	Naval Hospital.
Gerrish's Wharf	42 23 4.460	71 2 18.384	480.24	2.6814565	50 34 24.6	230 34 13.7	Chelsea Bridge.
			800.12	2.9031574	302 21 17.1	122 21 37.0	East Boston Reservoir.
Condor	42 22 55.854	71 2 6.447	645.20	2.8096934	86 29 42.2	266 29 23.2	Chelsea Bridge.
			380.86	2.5807608	134 12 11.4	314 12 3.4	Gerrish's Wharf.
Chelsea Draw Post . . .	42 23 5.688	71 2 28.713	368.37	2.5662846	21 26 48.1	201 26 44.1	Chelsea Bridge.
			1,024.33	3.0104392	297 3 45.6	117 04 12.5	East Boston Reservoir.
			592.81	2.7729130	300 46 49.6	120 47 4.6	Condor
Meridian Street Pipe . . .	42 23 5.265	71 2 1.976	307.85	2.4883343	19 24 12.5	199 24 9.5	Condor.
			376.11	2.5753181	86 12 56.9	266 12 45.8	Gerrish's Wharf.

[C.]

REPORT OF PROF. HENRY L. WHITING ON THE INSPECTION OF THE TOPOGRAPHY OF THE RE-SURVEY OF THE WHARF LINES OF BOSTON UPPER HARBOR.

To Hon. C. P. PATTERSON, *Superintendent United States Coast Survey, Washington, D.C.*

Dear Sir, — I present herewith a report of the completion of the topographical work connected with the re-survey of the wharf-lines of Boston Upper Harbor by the honorable Board of Harbor Commssioners, which, at their request, you directed me to supervise.

This part of the survey has been executed by Mr. William E. McClintock, formerly of the Coast Survey, assisted by Mr. William T. Blunt, the assistant engineer and clerk of the commission. The working force of the field party has been reduced to the minimum; and, while the survey has been carried on efficiently, it has been done at less current expenditure than was allotted to it in the original estimate for this branch of the work. The result has been, that, while the greater cost of the triangulation left a reduced allowance for the topography, as much work has been done, and as large a part of the harbor frontage gone over, as was projected in the original plan of work.

The accuracy and style of this survey are of the first order, and the details minutely represented. These include the marginal ground between the outer faces of the wharves and the first street bordering the general wharf line. Within this space the outlines of all structures are determined. By a system of conventional signs, the character of each structure is expressed, — in wharves, distinguishing between pile-work and solid filling; and in buildings, between wood and brick or stone. This marginal work embraces a large amount of detail of value in the study and treatment of change and improvement in the harbor frontage.

After consideration a larger scale was adopted by the commission for the maps of the re-survey than that used in the survey of 1860, '61, '62, by Mr. Boschke for the United States Advisory Council, which was $\frac{1}{2400}$. The change from this scale was mainly for the purpose of conforming to the metric system in measurement. The re-survey just made is contained upon twelve original plane-table sheets, on full-sized antiquarian paper, and fully occupying their space. Eleven of these sheets are on the scale of $\frac{1}{1000}$, and include Fort Point Channel from Dover Street Bridge to its mouth, the South Boston sea walls and dock, the frontage of the city proper, Charles River from the Navy Yard to West Boston Bridge, Chelsea Creek from the Navy Yard to Meridian Street and Chelsea Bridges, with the improvements of the Lowell Railroad Company, and the south channel of Mystic River, and the frontage of East Boston. One sheet, on the scale of $\frac{1}{2000}$, includes Charles River, on Cambridge basin, from West Boston Bridge to Brookline Bridge.

In executing the topography on this large scale, it became necessary to add to the original triangulation of Mr. Blake by interpolated points along the immediate harbor frontage. Eighteen of these new points were determined by Mr. McClintock from the bases given by Mr. Blake. The total number of points of triangulation, as the complement determined in the re-survey, is sixty-seven.

Owing to my required presence with my Coast Survey party on the Hudson River, and the recent closing of the Boston Harbor re-survey, I have neither had the time nor opportunity to verify all of the topography of the latter work. But those sheets which I have examined in the field have proved to be first-class in every respect.

I understand your instructions to authorize my inspection of all the topographical work of this re-survey. It is the wish of the commission that I should do so at a future practicable and convenient time. Some supervision may also be desirable in the final treatment of the original sheets.

The expenses of the survey have been carefully disbursed by the Commissioners; and the work closed with the expenditure of the appropriation made for it.

Respectfully submitted,

HENRY L. WHITING.

[D.]

BOSTON, April 20, 1878.

To the Honorable Senate and House of Representatives of the United States in Congress assembled.

The undersigned, Harbor Commissioners of the State of Massachusetts, authorized by law to memorialize Congress in behalf of the protection and improvement of the harbors of that Commonwealth, respectfully represent:

That Scituate Harbor is one deserving protection and improvement.

This harbor is situated at a protruding part of the outward trend of the western shore of Massachusetts Bay, and nearly midway between Boston and Plymouth Harbors, being about thirteen miles from Boston Light, and about fifteen miles from Gurnet Light. In character Scituate Harbor is a shallow fiord, with no tributary inland waters. It is open to the eastward, but protected from the north and north-east by Cedar Point, which is the northern arm of the harbor. A spit makes out from this point, and serves as a further partial breakwater. This point is subject to the wasting action of the ocean, and has already been much reduced. The former light-house, which still remains, — although the light has been discontinued, — is situated upon the end of this point.

Vessels forced upon this part of the coast in stress of weather, sometimes cannot "weather" the Cohasset Rocks and Minot's Ledge, which lie between it and Boston Harbor. Coasters, fishing-vessels, and pleasure boats and yachts, which, in cruising nearer the shore and in running the "gangway" passage through the Cohasset Rocks, pass closer to Scituate, and may make it a harbor when they cannot reach other shelter.

In view of the nature and capacity of Scituate Harbor, a large appropriation and expensive work may not be expedient; but the Commissioners would urge that Cedar Point may be protected from further waste, and that some improvement in deepening the entrance of the harbor may be made.

F. W. LINCOLN.
F. A. NYE.
ALBERT MASON.

[E.]

STATEMENT OF OPERATIONS DURING THE YEAR ENDING DEC. 31, 1878, ON WORKS FOR THE IMPROVEMENT OF RIVERS AND HARBORS IN THE STATE OF MASSACHUSETTS, UNDER THE CHARGE OF B'VT. BRIG. GEN'L GEORGE THOM, LIEUT. COL. OF ENGINEERS.

I. — Improvement of Boston Harbor, Massachusetts.

Of the work projected for the continued improvement of this harbor, under the appropriation made therefor by the River and Harbor Act of Aug. 14, 1876, there remained uncompleted on the 1st of January, 1878, the following, viz.: —

1. Under a contract made June 4, 1877, with Mr. George W. Townsend of Boston, Mass., for breaking up and removing, to a depth of 23 feet at mean low water, about 290 cubic yards of sunken ledges, situated in the main ship channel at the Upper Middle, and near (above and below) Kelly's Rock, the contractor had completed the removal of the only spur *above* Kelly's Rock (containing $26\frac{42}{100}$ cubic yards), and 50 cubic yards of the ledge *below* Kelly's Rock; leaving to be completed, on the 1st of January, 1878, the removal of about $131\frac{1}{2}$ cubic yards of the ledge below Kelly's Rock, and 82 cubic yards of ledge at the Upper Middle.

2. The completion of the removal of the sunken bowlders and ledge scattered over Nash's Rock Shoal (situated in the entrance of Boston Harbor), so as to have a depth of not less than $20\frac{1}{2}$ feet at mean low water, being an increase of about 7 feet in depth on its shoalest part. About one-half of this work was done by contract in 1876; and, of the remainder, about 320 tons of large bowlders and ledge were removed in Sept. 4 to Nov. 8, 1877, by a submarine party, with vessel and crew hired by the day. Work was then suspended for the winter; leaving only about 45 tons to be removed for the completion of the work, which was entirely completed in August last.

On the 8th of April, 1878, Mr. Townsend commenced work under his contract for the removal of the sunken ledge at the Upper Middle, of which he had broken up and removed, up to the 1st of July, 50 cubic yards; and on the 20th of August the remaining 32 cubic yards were completed by him. He then resumed work upon the ledge below Kelly's Rock, and continued until the 1st of December, 1878, when he suspended work for the winter, on account of the boisterous and unfavorable weather; he having, since the 20th of August, broken up and removed to grade 107 cubic yards of this ledge, making altogether 157 cubic yards of it removed by him to date, and leaving but $24\frac{1}{2}$ cubic yards of it to be done, for the entire completion of his contract.

The sea wall, which was built in 1868 and 1869 for the protection and preservation of the south-east bluff of Lovell's Island, having been so much damaged by the violent easterly gales to which it is exposed as to render its reconstruction necessary for a length of about 600 feet of its southern part, it was decided to increase its height 4 feet (two courses), and to give additional thickness to it by means of concrete backing ; also to protect its foundation, and the stone in front of it, by means of a rubble-stone apron ; and to protect and preserve the bluff in its rear by a substantial paving of large blocks of split granite firmly imbedded in gravel and shingle. Proposals were invited on the 9th of May last for all the stone required for this work, for which seventeen bids were received, and opened on the 31st of May. Contracts were made with the lowest responsible bidders for the same, as follows, viz. : —

With Mr. Isaac A. Sylvester of Quincy, Mass., for furnishing and delivering at Lovell's Island, —

5,700 cubic feet, more or less, of dimension-cut granite, at 39 cents per cubic foot ; and 500 tons, more or less, of split granite, for paving, at $1.80 per ton of 2,240 pounds.

Also with the Cape Ann Granite Company of Gloucester, Mass., for

1,100 tons, more or less, of rubble-stone, at 59 cents per ton of 2,240 pounds.

All this stone has since been furnished and delivered under the contracts. A wharf was built on the south side of Lovell's Island for the purpose of receiving the stone; also a railway about 1,000 feet in length, leading from the wharf to the most northern end of the sea-wall. This work was carried on with hired labor from the middle of June until the 9th of December, when it was suspended to be completed next spring. The reconstruction of the sea-wall (proper) has been completed, as well as the rubble-stone apron in front of it; and the filling back of the wall has been completed to the height required for the back paving, leaving only the paving to be laid next spring, all the stone for which is now on hand. This work has, in part, been done under the appropriation of $55,000 made for the improvement of this harbor by the River and Harbor Act of June 18, 1878.

Under this same appropriation contracts have been made for the completion of the works, upon the estimates for which the appropriation was based, viz. : —

1. On the 15th of August, 1878, with Mr. Joseph E. Bartlett, the lowest of eight bidders for the removal of Man-of-war Shoal (situated in the upper harbor at the confluence of Charles and Mystic Rivers) to a depth of 23 feet at mean low water by 65,000 cubic yards, more or less, of dredging at 27 cents per cubic yard as measured in scows, the same to be completed on or before the 10th of June, 1879.

2. On the 26th of August, 1878, with Mr. Isaac A. Sylvester of Quincy, Mass., the lowest of three bidders, for breaking up, and removing to a depth of 23 feet at mean low water, a sunken ledge situated near Kelly's Rock, containing 145 cubic yards, more or less, at $43 per cubic yard measured *in situ*, the same to be commenced on or before the 15th of April, 1879, and to be completed on or before the 1st of December, 1879.

Dredging operations were commenced at the Man-of-war Shoal on the 26th of August last, and have been carried on, day and night, up to the present time, resulting in about 35,000 cubic yards to date under the contract, whereby the work for the removal of this shoal is about one-half done. The contractor purposes to continue these operations throughout the winter unless prevented by ice or other difficulties.

It having been found necessary to make some repairs on the several sea walls built on the north head of Lovell's Island, Gallop's Island, the north head of Long Island, the north head of Deer Island, and on Rainsford's Island, this work was commenced on the 17th of September, and completed to the extent deemed necessary on the 29th of November; it having been done by hired labor, and with material purchased in open market.

From the foregoing statement it is seen that the only work that now remains to be completed under the appropriations of Aug. 14, 1876, and June 18, 1878, consists of —

1. The completion of the dredging at the Man-of-war Shoal, now about one-half done;
2. The breaking up and removal of about 24½ cubic yards of sunken ledge below Kelly's Rock, under contract of June 4, 1877; and
3. The breaking up and removal of about 145 cubic yards of sunken ledge below Kelly's Rock, under contract of Aug. 26, 1878.

The work done previous to January, 1878, for the improvement of this harbor, in addition to the several works above described, consists of the following; viz., —

I. — The main ship channel has been straightened, widened, and deepened, so as to have a width of not less than 600 feet, and a depth of 23 feet at mean low water at the following places: viz., —

1. At the west end of Great Brewster Spit;
2. At the south-east and south-west points of Lovell's Island;
3. At the Upper Middle Bar;

whereby this channel, from the entrance of the lower harbor up to Anchorage Shoal, has a width of not less than 600 feet, and a depth of 23 feet at mean low water (or about 32½ feet at ordinary high water), except at the Lower Middle where it requires widening, and near Kelly's Rock where obstructed by the sunken ledges recently discovered to be 3½ feet shoal.

II. — *Sea walls* have also been built, for the preservation and protection of the headlands in the harbor, at Point Allerton, Great Brewster Island, Lovell's Island (north head), Gallop's Island, Long Island (north head), Rainsford Island, and Deer Island (north, middle, and south heads); all of which are now generally in good condition.

III. — *Sunken rocks* have also been broken up and removed as follows, viz.: —

Kelly's Rock, Tower Rock, Corwin Rock, the ledges recently discovered at the west end of Great Brewster Spit, and between there and George's Island (all situated in the main ship channel at "the Narrows"), to a depth of 23 feet at mean low water. Barrel Rock in Broad Sound, State and Palmyra Rocks situated about one-half a mile east of Castle Island, have also been removed.

Surveys and estimates have also been made and submitted to the U. S. Engineer Department, and an appropriation has been asked for the additional works for the improvement of this harbor, viz.: —

1. Deepening and widening the main ship channel at Anchorage Shoal (next above the Upper Middle) to a depth of 23 feet at mean low water, for an average width of 1,100 feet; this width being necessary, in this central position of the harbor, to enable vessels on entering or leaving the main channel to have free communication with all parts of the harbor, above and below, the estimated cost of which is . . .	$90,000.00
2. Increasing, to a width of 600 feet, the main ship channel at the Lower Middle, the estimated cost of which, is .	5,000.00
3. Straightening, widening, and deepening the main channel near the Navy Yard and mouth of Mystic River, so as to have a depth of 23 feet at mean low water, for a width of 300 feet, the estimated cost of which is . . .	70,000.00
Total	$165,000.00

II. — Merrimac River, including the Harbor of Newburyport, Massachusetts.

The project adopted for the improvement of this *river* consists in deepening its shoals by dredging, and the removal of sunken rocks from its channel, so as to afford a depth of 12 feet at ordinary high water, from its mouth in Newburyport Harbor in Massachusetts, up to Haverhill (a distance of 15 miles), and thence for a distance of about 4 miles, up through "the falls," a depth of 4 feet in the ordinary stages of the river; and that for the improvement of Newburyport Harbor consists in the removal of the Gangeway Rock and the North (Gangeway) Rocks, to a depth of 9 feet at mean low water, the removal of the "Boilers" (a sunken ledge near the city wharves) to a depth of 5 feet at mean low water, and other obstructions to navigation lying in the main channel near the mouth of Black Rocks Creek, and elsewhere.

For the improvement of the river above Newburyport Harbor, the following work has been completed, to date, viz: —

The channel completed at Hazeltine Rapids, Lower Falls, and Upper Falls (above Haverhill, Mass.), so as to be navigable through "the falls" for a depth of 4 feet in all stages of the river, except in an unusually low stage, resulting from shutting off the water at the Lawrence Mills on Sundays and at night; shoals dredged, and sunken bowlders removed from the channel at and near Rock's Bridge (6½ miles below Haverhill), including Little Currier Rock above, and Petty Rock below the bridge, greatly improving this, the most dangerous part of the river below Haverhill; the channel opened by dredging, for a width of 100 feet, to the projected depth, viz., 12 feet at ordinary high water, at Currier's Shoal (distant about 5 miles below Haverhill); also to the same depth, and for a width of 75 feet, at the shoals near the head and foot of Silsby's Island, from 1 to 2 miles below Haverhill. The shoal between the two bridges at

Haverhill has also been improved by dredging so as to have a channel 10 feet in depth at ordinary high water, and numerous large bowlders have been removed from the channel at and near "the falls" above Haverhill; also about 80 tons of bowlders have been removed from the channel near the head of Silsby's Island.

For the improvement of Newburyport Harbor, the following work has also been done, viz.: —

1. The Gangeway Rock, for the most part reduced to grade in the year 1870, and the sunken wreck of the schooner "Globe," entirely broken up and removed in the same year. Under the appropriation of $10,000, made by the River and Harbor Act of June 18, 1878, a contract was made Aug. 10, 1878, with Mr. Isaac A. Sylvester of Quincy, Mass. (the lowest of five bidders), for breaking up and removing, to a depth of 9 feet at mean low water, 300 cubic yards, more or less, of the North (Gangeway) Rocks, at $28 per cubic yard, measured *in situ*. Work was commenced under this contract on the 24th of August, 1878, and prosecuted up to the 20th of December, whereby about 170 cubic yards of the rock has been removed to grade, with a probability of the completion of the contract in the time required, viz., not later than the 30th of June, 1879.

The work then remaining to be done for the further improvement of this harbor will consist of, —

1. Completing the breaking up and removal of about 160 cubic yards of the North (Gangeway) Rocks, to a depth of 9 feet at mean low water.
2. Completing the removal of the main "Gangeway Rock" to a depth of 9 feet at mean low water, where shown by recent surveys to have (in one place) less than the required depth.
3. Breaking up and removing about 350 cubic yards of "The Boilers" to a depth of 5 feet at mean low water.
4. Removing four dilapidated sunken piers, abreast of Black Rocks Creek, — they being formidable obstructions to navigation, — one of them having but 6 feet of water over it at mean low water.
5. Removing a very large bowlder, 15′ x 13′, by 7′ high, which lies in 15 feet of water, in the main channel between the north and south piers, and has but 8 feet of water over it at mean low water.

The appropriation of $10,000, made for this harbor by the River and Harbor Act of June 18, 1878, will all be applied to the partial removal of the North (Gangeway) Rocks, to the extent contracted for; and for the further improvement of the harbor, the additional sum of $15,000 has been asked, for the fiscal year ending June 30, 1880.

III. — IMPROVEMENT OF PLYMOUTH HARBOR, MASSACHUSETTS.

The existence of this harbor depends entirely upon the protection and preservation of Long Beach; which is a narrow strip of land that extends 2¾ miles out from the mainland, in a north-westerly direction, nearly parallel to the shore of the town of Plymouth, and distant from it about one mile. It affords to the harbor its only shelter from easterly storms. In late years it has been washed away in some places, and much weakened in others, to an extent seriously threatening the ruin of the harbor. For the protection and preservation of this beach, various works have been built, from time to time, until finally they have proved efficient and successful.

These works consist of bulkheads, jetties, and groins, built for the accumulation of sand, and the planting of beach-grass, also to accumulate sand and give permanency to the beach thus formed; whereby a ridge has been formed throughout the whole extent of the beach, which is for the most part covered with beach-grass, and is now in an efficient condition.

Exposed as this beach is to injury from violent easterly storms, it necessarily requires occasional repairs. For the permanent preservation of the extreme outer end of the beach, near the beacon, a rubble-stone bulkhead has been built. But, owing to its exposed position, the beach has not grown to the extent desired; so that it has been found necessary to extend this bulkhead farther round the end of the beach.

Under the appropriation of $5,000 made for this harbor by the River and Harbor Act of June 18, 1878, the work for the extension of the stone bulkhead, and the repairs of the other works where necessary, has been carried on from the 20th of August to the end of November last, — the work having been done by hired labor, with stone and other materials purchased in open market. This work has all been completed, with the exception of the stone bulkhead, which has been suspended for the winter, with a probability of its early completion next season.

Under an appropriation of $10,000 by the River and Harbor Act of March 3, 1875, for the improvement of this harbor, a channel was opened, by dredging from the Middle Ground up to Long Wharf, a distance of about 2,500 feet, to a depth of 6 feet at mean low water (or 16 feet at mean high water), and for a width of 50 feet.

The project originally provided for a channel 100 feet in width, to be extended southward to the mouth of Town Brook, a distance of about 900 feet above Long Wharf, so as to form a basin in front of the wharves of the city, 125 feet in width, with a depth of 8 feet at mean low water.

For the completion of this project, the additional sum of $25,000 was asked in my last annual report to the chief of engineers, since published by Congress.

IV. — IMPROVEMENT OF PROVINCETOWN HARBOR, MASSACHUSETTS.

Under the appropriation of $1,000 made by the River and Harbor Act of June 18, 1878, for the preservation and improvement of this harbor, operations have been confined to the extension of the stone bulkhead on Long Point, and planting beach-grass at Cove Section along the beach newly formed by the bulkhead and jetties built in 1874. This work was commenced in the latter part of August, and continued until the first of October; in which time 506 tons of rubble stone was placed in the bulkhead, beach-grass planted, and the repairs completed where necessary on all the works built for the preservation and improvement of this harbor; so that they are now in excellent condition, fully answering the purpose for which they were designed. They will, however, require continual watching and occasional repairs, exposed as they are to injury from the violent storms which at times occur in that locality. For this purpose an additional appropriation of $1,000 was recommended in my last annual report.

V. — Survey of Scituate Harbor, Massachusetts.

A survey of this harbor, with a view to its adaptability as a harbor of refuge, was made under my direction in September last, as called for by the River and Harbor Act of June 18, 1878; and a special report thereon has been forwarded to the chief of engineers, U.S. Army, together with a map, plan, and estimates for the work.

VI. — Survey of Charles River, Massachusetts.

A survey of this river to the head of tide-water, with a view to the improvement of its navigation, was made under my direction in November last, as called for by the River and Harbor Act of June 18, 1878; and a special report thereon has been forwarded to the chief of engineers, U.S. Army, together with maps, plans, and estimates for the work.

[F.]

ABSTRACT OF REPORT OF GEN. G. K. WARREN

TO

Chief of U. S. Engineers, for 1878.

B 1.

IMPROVEMENT OF HYANNIS HARBOR, MASSACHUSETTS.

Hyannis is situated on the south side of Cape Cod, on Nantucket Sound. Hyannis Harbor is the sheltered area between the breakwater and the shore.

This breakwater is about 1,170 feet long, with a depth of 12 feet at mean low water between it and the shore. It was begun in 1828, and continued with few interruptions until 1837; $70,931.82 having been expended upon it. In 1853 $5,000 was expended in repairing the east end.

Since 1870 $37,000 has been expended in rebuilding the part above water, and increasing the width of the part below low water.

Nothing has been done on the breakwater at this place during the fiscal year.

An appropriation of $3,000 was made by Act of Congress approved June 18, 1878, for continuing the improvement. With this amount it is proposed to strengthen the breakwater by putting riprap granite about its base, so as to increase the slope to one on two on the seaward side, and one on one on the shore side.

A history of this work was given in the Annual Report of the Chief of Engineers for 1875, part ii., pp. 266–268.

The amount then estimated as required to complete the work was $10,000. This amount, less the amount appropriated this year, is needed to give the work the required width of base.

I would call attention to the importance of putting a light-house on the east end of the breakwater instead of the present one on the shore.

Hyannis is in the Barnstable collection district. Barnstable is the nearest port of entry. The amount of revenue collected there during the fiscal year ending June 30, 1878, is not known to this office.

Money Statement.

July 1, 1877, amount available	$42 94	
Amount appropriated by Act approved June 18, 1878 . .	3,000 00	
		$3,042 94
July 1, 1878, amount expended during fiscal year . . .		42 94
July 1, 1878, amount available		$3,000 00

Amount (estimated) required for completion of existing project	$7,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1880	7,000 00

B 2.

IMPROVEMENT OF WAREHAM HARBOR, MASSACHUSETTS.

This harbor is an estuary joining Buzzard's Bay near its upper or northern end. The part improved by the general government extends from Wareham, where it is crossed by a railway and a highway bridge, neither of which has draws, to Buzzard's Bay, a distance of 2 miles. The improvement of this harbor, which was completed in 1876, was to make a channel 9 feet deep at mean low water, and from 100 to 300 feet wide, in the upper part of the harbor; and 10 feet deep, and from 250 to 300 feet wide, in the lower part of the harbor. The mean rise of the tide is 4 feet. The depth before the improvement commenced was 7½ feet at mean low water, in a narrow and crooked channel.

A history of the improvement may be found in Annual Report of the Chief of Engineers for 1877, part i., pp. 194–196. The work done under the last two appropriations was at a much less price than estimated, so that we had about $2,000 remaining on hand when the improvement was completed. With this amount it was deemed best to build a "sand-catcher" along Long Beach, to arrest the sand carried over it by the waves in storms into the harbor. This work was commenced last season, and will be completed in this season.

No further appropriation is needed, unless a greater depth is required than when the plan was adopted.

Wareham is a port of delivery. It is in the New Bedford collection district, and New Bedford is the nearest port of entry. The amount of revenue collected there during the fiscal year ending July 30, 1878, was $23,762 33.

Money Statement.

July 1, 1877, amount available	$2,057 74
July 1, 1878, amount expended during fiscal year	1,153 38
July 1, 1878, amount available	904 36

B 3.

IMPROVEMENT OF NEW BEDFORD HARBOR, MASSACHUSETTS.

This harbor is an arm of Buzzard's Bay on its north shore, and receives the waters of the Acushnet River. It is the terminus of the New Bedford division of the Boston, Clinton, and Fitchburg Railroad, by means of which it has become a large distributing point for anthracite coal. There are also large manufacturing establishments, and it has the largest whale-fishing fleets of any port on our coast. The population of New Bedford, and Fair Haven opposite it, is about 25,000.

A survey was made by authority of Congress in 1874, a report of which is printed in the Annual Report for 1875, part ii., pp. 283–287. The project submitted was to make a channel 200 feet wide and 15 feet deep at mean low water, from the deep water in front of Fair Haven to the wharves at New Bedford across the shoals, where the ruling depth before was 12½ feet at mean low water. The mean rise of the tide is 3.7 feet.

The depth of 15 feet was adopted here because that was about all that vessels could carry over the shoals before reaching Fair Haven.

The amount estimated to complete the work was $24,000.

An appropriation of $10,000 was made by Act approved March 3, 1875. Contract with the lowest bidder, the Atlantic Dredging Company, for 17½ cents per cubic yard, made a channel 15 feet deep and 105 feet wide. The line of it is straight from deep water at Fair Haven to Commercial Wharf, New Bedford, the first location being a little changed to secure better ranges for sheering.

Another appropriation of $10,000 was made by act approved Aug. 14, 1876, but the work was not authorized until the following April. A contract was made with Mr. W. H. Molthrop (Morris F. Brainard doing the work), the lowest bidder, at 10¼ cents per cubic yard. The low price caused delays in executing the contract, and the time had to be extended to June 30, 1877.

The low price not only enabled us to complete the channel to the width first planned, but to increase it to a width of 300 feet, and to extend it nearly 1,000 feet farther up the harbor along the harbor-line in front of the wharves occupied by the whalers, and to the channel leading to the basin above the bridge.

The Reading Railroad Company have done considerable dredging from this new channel to their wharves.

The material dredged by the government was first dumped in Clarke's Cove, afterward east of Egg Islands, both places entirely out of the harbor.

No appropriation was asked for the fiscal year ending June 30, 1879. None is asked for the succeeding fiscal year, as the improvement, as far as authorized, is completed.

The operations in the last fiscal year were superintended by Mr. H. A. Bentley, assistant engineer.

Money Statement.

July 1, 1877, amount available	$9,654 60
July 1, 1878, amount expended during fiscal year	8,852 78
July 1, 1878, amount available	801 82

B 4.

IMPROVEMENT OF FALL RIVER HARBOR, MASSACHUSETTS.

Fall River, the largest cotton-manufacturing town in the United States, is situated on Mount Hope Bay, an arm of Narragansett Bay. Fall River Harbor is that part of the bay in front of the town. The part improved by the general government lies between the Rodman Wharf and the wharf used by the steamers running to Providence, a distance of about 1,500 feet. The improvement sought was a channel 12 feet deep, and 100 feet wide at the narrowest part, at mean low water, where the depth was from 6 to 12 feet. The mean rise of tide is 4.7 feet. The harbor was surveyed in September, 1873; and a report with plan and estimates submitted by me Dec. 31, 1873, and printed in Annual Report of the Chief of Engineers for 1874, part ii., pp. 284–286.

The amount estimated as necessary to complete the improvement as designed was $45,000.

By Act of Congress approved June 23, 1874, $10,000 was appropriated for this work. With this amount the bowlders lying on the surface were removed by contract, at the rate of $3.50 per ton. The amount removed under this contract was 1,047¾ tons of bowlders, and 364 tons of gravel and small bowlders. An additional appropriation of $10,000 was made by Act of Congress approved March 3, 1875. This, with the unexpended funds of the previous appropriation, was expended in removing, by contract, 21,222.19 cubic yards of material, including bowlders of 2 cubic yards and less, at 48 cents per cubic yard, and 136.53 cubic yards of bowlders over that size.

By Act of Congress approved Aug. 14, 1876, $10,000 was appropriated for this work. This was expended, by contract, during the present fiscal year, in removing 12,857½ cubic yards of material, including bowlders of 1 cubic yard, at 55 cents per cubic yard, and 176.34 cubic yards of bowlders over 1 cubic yard in size, at $8.40 per yard.

The low prices at which the dredging was done enabled us to make a channel 160 feet wide and 12 feet deep, with an additional width of 100 feet 11 feet deep at mean low water, with the $30,000 appropriated. The original estimate was $45,000 for a channel 100 feet wide. The cost of dredging was estimated at $1 per cubic yard: it was done at 48 and 55 cents.

The improvement is now completed with a channel of the depth sought and an increased width.

This improvement is in the Fall River collection district, and Fall River is the port of entry. The amount of revenue collected there during the fiscal year ending June 30, 1878, is $18,970.05.

The work during the past year has been under the superintendence of Mr. H. A. Bentley, assistant engineer. In November and December, 1875, while the improvement was being prosecuted, tidal observations for a lunation were made in order to establish a mean low water plane, and determine the rise and fall of tide. The following is a table of these observations: —

Date.	High water.	Low water.	Date.	High water.	Low water.
1875.	Feet.	Feet.	1875.	Feet.	Feet.
November 9 .	6.3	2.4	November 24 .	5.9	2.7
10 .	6.7	2.0	26 .	6.9	2.4
11 .	7.0	1.8	27 .	6.8	2.0
12 .	7.1	1.4	29 .	7.0	1.9
13 .	7.4	1.0	30 .	6.2	1.7
15 .	7.5	1.4	December 1 .	6.7	2.0
16 .	7.2	1.0	2 .	6.4	2.3
17 .	6.8	1.3	3 .	6.2	2.7
18 .	6.1	1.5	4 .	6.5	2.2
20 .	5.6	2.1	6 .	6.4	2.4
22 .	6.4	2.0	7 .	6.6	2.1
23 .	6.6	2.5			

Mean rise and fall, 4.7 feet. Mean low water is referred to a bench-mark, which is the top of the foundation-stone at the north-west corner of Massasoit Flour Mill. It is 9 feet 7 inches above mean low water. An arrow cut in the stone points to the mark.

Money Statement.

July 1, 1877, amount available	$10,256 47
July 1, 1878, amount expended during fiscal year	10,256 47

B 5.

IMPROVEMENT OF TAUNTON RIVER, MASSACHUSETTS.

This estuary, or so much of it as has been improved by the general government, extends from Weir to Dighton, a distance of about six miles, where it joins or widens out into a bay. The name Taunton River is, however, sometimes applied to this estuary as far down as Fall River, 7½ miles below. At Weir it is spanned by a draw-bridge, with two openings of about 40 feet each. At low water the river is in many places less than 100 feet in width, and before dredging there was not more than 1 foot depth in the shoalest places. The mean rise and fall of tide at Dighton is 5.28 feet ; at Weir, since the improvement, 3.41 feet : before any improvements were made, it was probably not greater than 2½ feet at the latter place, but the exact range then is not known.

The improvement sought at first was to get small sailing-vessels up to Weir. In 1852 a survey was made by Lieut. Rosecrans ; and in December, 1853, an estimate for a channel 60 feet wide and 4 feet deep at mean low water was submitted by Capt. George Dutton, United States Engineers. In March, 1870, Capt. J. A. Smith, United States Engineers, in a report upon this improvement, estimated for a channel of the same dimensions as that of Capt. Dutton. An appropriation of $10,000 was made by Congress July 11, 1870, and another appropriation of $10,000 by Act approved March 3, 1871. These amounts were expended in dredging a channel through the "Needles." On the completion of this dredging, Gen. Thom, United States Engineers, had a survey made, and from this survey made an estimate of the amount of material to be removed to secure a channel 9 feet deep at mean high water up to Weir.

The amount estimated as necessary to be removed was 31,000 cubic yards, or about twice as much as for the improvement of Capt. Dutton in 1853 and Capt. Smith in 1870.

It will be observed that the depth sought in Gen. Thom's plan was 9 feet at high water, while that estimated for by Capts. Dutton and Smith was 4 feet at mean low water. This, with the mean rise of about 3½ feet at Weir, would give a draught of about 7½ feet at mean high water.

At the time the first estimates were made, only small sailing-vessels ascended the river at high-water; and the smallest of these only went above the obstructions at the "Needles," the others unloading below. As soon as the channel was dredged through the "Needles," larger vessels were employed, and tugs used to tow them up and down the river.

This work was transferred to my charge July 1, 1872. The appropriation of $10,000 made by Act approved June 10, 1872, was expended by me in dredging a channel through Burt's Shoal and Pond's Rocks Shoal, 60 feet wide and 4½ to 5 feet deep at mean low water, in accordance with the plan submitted by Gen. Thom. Surveys were made during the season of the shoals not before surveyed. A set of observations were made to establish the low and high water planes from Dighton to Weir. The appropriations of $10,000 made by Act approved March 3, 1873, and $10,000 by act approved June 23, 1874, were expended in dredging and removing bowlders. In April, 1873, a survey was made of the channels dredged, of the shoal above Berkley Bridge, of the obstructions at the "Nook" at Peter's Point, and of Cobb's Shoal at Dighton. No detailed examinations had been made at these points, and only approximate estimates for the removal of the obstructions.

As before stated, vessels are almost invariably towed up and down this river. The tugs, with their vessels and scows, start from Dighton on the flood-tide as soon as they can cross the rocks and shoals in that part of the river, in order to reach Weir by or before high water, and that a new tow can be formed to take down the river on the first of the ebb

If any delay occurs in taking the tow up, so that they cannot leave Weir until after ebb has commenced, they will not reach the obstructions at and near Dighton until the tide has fallen 2 feet. Here, then, under these circumstances, we would not have secured a 9-foot draught for vessels by making 9 feet depth at mean high water. To do this it was determined to make in the work below the "Needles" 10 feet depth at mean high water.

With the $10,000 appropriated by Act approved March 3, 1875, a channel 10 feet deep at mean high water was dredged through Cobb's Shoal at Dighton, and of the same depth at Wikamount, and bowlders removed from the "Nook," and the point of the ledge extending into the channel-way at Peter's Point. This completed the improvement designed to allow vessels of 9-feet draught to ascend to Weir at time of mean high water, except the shoal at Berkley Bridge and some bowlders scattered along the channel and in sharp bends.

To do this it was estimated $5,000 would be required. With 9 feet secured in this river, except on the sand-shoal at Berkley Bridge, which lacks but a few inches of the required depth, vessels and barges have been employed drawing nearly or quite this depth ; and as the tugs start with them at Dighton before high water, they strike at Berkley Bridge Shoal, and often at new shoals and bowlders above, which probably have 9 feet at mean high water, but not at any lower stage of the tide.

The barges used here are very long, and frequently in making the short turns strike both banks of the channel.

The bowlders are dangerous obstructions ; and with the $2,000 appropriated by Act of Congress approved June 18, 1878, it is proposed to remove them as far as the funds will pay for. The removal of Berkley Shoal to 10 feet depth at mean high water would allow vessels to go farther up before striking ; but it is deemed best to leave this as a limiting depth, and use the available funds in removing bowlders to give increased depth and width. The improvement of this river will be substantially completed, as designed, to give 9 feet draught with the expenditure of $5,000, estimated for by me in Annual Report of Chief of Engineers for 1876, part i., pages 205, 206. This will require an appropriation of $3,000 in addition to the amount now available ; which is asked for the fiscal year ending June 30, 1880.

A larger channel would be desirable, and no doubt will be asked for; but, with the completion of the improvement as originally designed, I do not feel authorized to estimate for any thing more.

Taunton River is in the Fall River collection district. The amount of revenue collected during the fiscal year ending June 30, 1878, was $18,970.05.

Money Statement.

July 1, 1877, amount available	$100 93	
Amount appropriated by Act approved June 18, 1878 .	2,000 00	
		$2,100 93
July 1, 1878, amount expended during fiscal year		100 93
July 1, 1878, amount available		2,000 00
Amount (estimated) required for completion of existing project .		3,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1880		3,000 00

HOUSE...... ......No. 25.

ELEVENTH ANNUAL REPORT

OF THE

BOARD OF HARBOR COMMISSIONERS.

JANUARY, 1877.

BOSTON:
ALBERT J. WRIGHT, STATE PRINTER,
79 MILK STREET (CORNER OF FEDERAL).
1877.

HOUSE...... ......No. 25.

ELEVENTH ANNUAL REPORT

OF THE

BOARD OF HARBOR COMMISSIONERS.

JANUARY, 1877.

BOSTON:
ALBERT J. WRIGHT, STATE PRINTER,
79 MILK STREET (CORNER OF FEDERAL).
1877.

REPORT.

Harbor Commissioners' Office, No. 8 Pemberton Square,
Boston, January, 1877.

To the Honorable Senate and House of Representatives of the Commonwealth of Massachusetts.

The Board of Harbor Commissioners respectfully submit their Eleventh Annual Report :—

South Boston Flats.

The reclamation of South Boston Flats, by the use of material for filling taken from the banks and bed of the main channel, has made fair progress during the past year. The twenty-five acre piece which the Commonwealth has undertaken to reclaim, has been walled in, substantially, as far as the first dock inclusive, and requires only about 64,000 cubic yards more (which the dredging of the dock will supply) to raise it to grade *thirteen*, above which the filling is to be of gravel.

The engineer seems to have foreseen so perfectly the degree to which the rubble underlying the heavy wall would yield to the pressure from above, that now, when time enough has elapsed, in his opinion, for the entire settlement to have taken place, the coping of the wall is found to be upon its predestined grade,—sixteen feet above mean low water. The sinkage has been about six inches, and so nearly uniform, that the wall may be said to have moved as a single mass.

Excepting the removal of a considerable body of shoal ground off Long Wharf, the dredging has been confined to a belt in front of the Commonwealth's property, and a connecting channel to deep water beyond. It is designed that the dock shall be accessible at low tide for vessels from sea drawing twenty-three feet of water, and this draught can now be carried past the front of it, into the mouth of Fort Point Channel.

The brief but comprehensive report of Mr. Edward S. Philbrick, engineer in charge, will be found in the Appendix, and may be referred to for a more precise description of the present state of the works.

In the plan for reclaiming these flats, retaining-walls of two kinds were projected: one of these was to be a heavy structure, with a rubble base resting at the bed-level of the main channel; the other, a light structure resting on piles about at the general level of the flats. Wherever the light wall was to be used, its site was set back some distance from the deep-water frontage, in order that the piles should be covered from the worms and sustained by the earth. The platform referred to by the engineer was designed to cover the shallow space between the channel and the wall, and serve as a bridge or wharf from the ship to the shore, as may be seen in the sketch accompanying the Sixth Annual Report. This platform was not, of course, to be a constituent part of the retaining-wall, and it was not anticipated that its construction would precede the demand for its actual commercial use, unless some tendency to erosion or slipping of the bank should manifest itself. The engineer, as will be seen, suggests that within the dock, where berths for ships of great draught are to be provided, the bank along the front of the light wall should be prevented from slipping, either by omitting some of the dredging, or by driving a row of spruce piles. The latter course appears to the Board most advisable; because, to omit any of the projected dredging in the dock might prejudice the sale of the property. These piles, imbedded in the mud, will neither perish from decay nor worms, so that their office will be permanent; and, as a guide to the dredging party, they will be of no small value, experience having shown that the utmost vigilance of the Board, the engineer in charge, and the inspector, fails to prevent irregularity in dredging, both as regards alignment and depth.

It was obvious, at the beginning of the year, that it was impossible for the contractors to complete their work by the first day of October, as stipulated in their contract; and the Legislature appropriated only what might be required within the year. It does not yet appear that the State will suffer from the delay of the contractor, and it is quite certain that in some respects the work is much better for less haste. Of the original estimate of the engineer, there remains unappropriated $98,521. If to this is added the sum named by him for the piling necessary to secure the bank from slipping, $4,000, the amount to be appropriated for the coming year, during which it is expected the work will be completed, is $102,521.

Dumping-grounds.

During the past season, the Board called the attention of the agents for the Commonwealth Flats at South Boston, to the fact, that in the execution of the dredging by the Board, in the application of the income from the compensation fund to harbor improvement, as well as in the dredging by private parties and corporations, there would be large amounts of material to be disposed of, valuable for filling.

The agents responded cordially, and, in conference, laid off a portion of the South Boston Flats, beyond and adjacent to the territory sold to the Boston & Albany Railroad Company, and, in conjunction with the said railroad company, built suitable bulkheads for securing the material from waste.

At the time that the engineers of the United States commenced their excavations at the Upper Middle Bar, the material removed had no market value, principally because the large scows used by the contractors drew too much water to be floated upon flats then in process of reclamation. The Board suggested about that time, that a location could be given for depositing the material upon the South Boston Flats, provided bulkheads should first be built to prevent its return to the main channel. It appeared, however, that the provisions of the appropriation bill, under which the dredging was being done, did not admit of any expenditure on constructions like that suggested. The Board then gave the ranges of an unfrequented portion of the Lower Harbor, near Hangman's Island (belonging to the Commonwealth), where the material could be dumped without injury to valuable channels. All other persons, whether contractors for the Commonwealth or for private parties, who could not usefully dispose of material of this kind, were directed to carry it to the same place. The Board was not without misgivings that the remoteness of the ground assigned might induce the bargemen, under cover of night, or amid the hardships of stormy weather, to unload prematurely; and therefore informally represented to the United States engineer, that the public interest would be best secured if the inspector, who made the count upon which the contractor was paid, could be located at Hangman's Island, and thus secure the delivery of material at the proper place. This arrangement could not be made, and the Board resorted to what seemed to be the next best course, which was to request the harbor-master, Capt. Francis C. Cates, to keep a strict watch, and report to the Board delinquencies of the kind referred to. This proved to be a very timely step; the vigilance of the harbor-master led to the discovery of several cases of scow-loads dumped in the channel-way, of which the Board made representation to the United States engineer, who ordered their removal, or the dredging of an equal amount from the shallowest part of the channel.

Shoals in Boston Upper Harbor.

In pursuance of the authority granted to the Board, the work of dredging the shoals in Boston Upper Harbor has been continued, and new work has been begun during the last season. Peculiar difficulties have arisen in dredging along the immediate front of the business portions of the city, which have caused unlooked-for delay and embarrassment in the execution of the work.

The new work commenced is that referred to in the last report of the Board, off the water-face of East Boston, and consists in the removal of the shoal ground in front of the south dock of the National Dock and Warehouse Corporation, and includes an area of about 68,400 square feet. Contracts have been made with the Harbor Improvement Company for the execution of this work, which has been nearly completed.

Petitions have been presented to the Board by the Cunard Steamship Company, and by the Boston & Albany Railroad Company, for the removal of shoals off their respective frontages in East Boston. A survey has been made of the ground in question, and an approximate estimate made of the dredging required, which amounts to about 103,000 cubic yards.

The localities referred to are shown in the Appendix, on a map, entitled "A Map of a portion of Boston Harbor." The petitions above referred to, will also be found in the Appendix.

CHARLES RIVER BASIN.

The Cambridge Improvement Company and others, acting under the license of the Board, dated April 27, 1875, have continued their improvements between West Boston and Cragie bridges, and have executed the following work:—

One hundred and twenty-three thousand four hundred and five cubic yards of material have been dredged as compensation for tide-water displaced by their structures and filling.

Five hundred linear feet of sea-wall have been built.

One hundred and seventy linear feet of foundation and ballast for sea-wall have been laid.

Seven hundred linear feet of wooden bulkheads have been built.

In addition to the above work, the city of Cambridge has built Binney Street sewer, and filled in material as ballast to it, which has been dredged from the channel of the basin above West Boston Bridge, to the amount of 7,000 cubic yards.

BOSTON LAND COMPANY.

The Boston Land Company has brought to the attention of the Board, a project for creating on the flats of the company lying on the south-easterly side of Breed's Island, occupied in connection with territory in tide-water beyond the line of the riparian title, a new and extensive water-frontage suitable for ocean steamers and vessels of the largest class. This frontage it is proposed to develop in connection with a tract of land to be raised to the proper grade from tide-water by filling, and to be improved for docks, wharves, warehouses, railroad tracks, and all the facilities for the landing and shipping of cargoes.

The construction of a ship channel, deep enough for vessels of the greatest draught of water, extending from the main channel of the harbor near Governor's Island, is an essential part of the scheme.

This enterprise, we understand, will be brought to the attention of the Legislature during the present session.

GREEN HARBOR RIVER.

As a basis for the action of the Board, the engineers were directed, during the last summer, to make a survey of Green Harbor River, in Marshfield, including the bar outside of the headlands of the harbor, or anchorage basin, and the part of the river above the basin and below the dike erected in 1872.

This survey has been accurately made. The tidal data have been obtained from observations made at Boston Light and at Green Harbor, and these results compared with those of Prof. Mitchell at Sandwich, taken in connection with his survey of 1860 for the Cape Cod Ship Canal, and also with the results of Col. Graham's surveys at Provincetown in 1833–35. From all these observations, the plane of mean low water for this part of Massachusetts Bay has been determined, and permanent bench-marks established at Green Harbor, to which all the levels of the recent survey refer.

The high-water outline of the beach, harbor and river, from Bluefish Rock to the dike, with some marginal topography, have been surveyed, and points identical with those of the United States Coast Survey of 1857 determined, sufficiently well to give a basis for the comparison of the high and low water lines of the two surveys. The contours of the bar, channel, and bed of the harbor basin, as far up as the lower end of the first marsh island, have been determined by numerous level stations.

At the time that the project for the dike was under consideration, no survey of the bar and mouth of the river was made. As far as could be observed, the Coast Survey map still represented the general features of the topography, and no change decidedly detrimental to navigation had occurred. No soundings were furnished upon the map just mentioned; but by inquiry of fishermen the surveyors satisfied themselves that the harbor proper had remained essentially the same; while it was manifest that a considerable increase of the beach separating Cut River from the sea had taken place, and this seemed to threaten the entrance, as a remote possibility.

As has been said, no soundings are furnished by the topographical map of the Coast Survey (1857), and therefore the estimate that will be first given of the *total* deposit which has taken place in the interval between the two surveys is only an approximation,—but a safe one, it is believed, in the respect that it is not an exaggeration. The portions of the two maps which have been compared may be distinguished as the *basin* and the *bar*,—the former being the space between the Narrows at Washburn's Point and the first marsh is land above, about 8⅓ acres as limited by the low-water lines of 1857; and the latter, the low-water space of 13¾ acres (1857) seaward of the Narrows, limited by the arc of a circle passing through the extremity of Bluefish Rock,—the said circle having a radius of 1,900 feet, with its centre at the outer end of the first wharf or stage now existing at Cut River Village.

In the basin, as above described, the total deposit amounts to about 52,000 cubic yards since the dike was projected; and on the bar, the total deposit since 1857 amounts to 106,000 cubic yards. The amount deposited in the basin, above *the plane of mean low tide and beyond the low-water lines* as they existed before the dike was projected, amounts to 23,000 cubic yards; while the amount similarly deposited upon the bar since 1857 amounts to 63,000 cubic yards.

It would be unwarrantable to attribute the whole accumulation over the spaces examined to the rëduction of the tidal scour which was formerly strong enough to keep the entrance free. The very fact that there are such great volumes of sand drifting along the coast, ready at every flood-tide, or inroad of storm seas, to enter all the rivers and creeks, might lead one to expect that gradually all basins (as distinguished from channels) are to be filled up. The case of Plymouth Harbor, in this very neighborhood, is the best illustration of this. The recent Coast Survey Chart, compared with those of the seventeenth and eighteenth centuries, shows that many millions of cubic yards of sand have accumulated in the main ship channel and in the bay below Brown's Island (see a report on the Physical History of Plymouth Harbor, in Appendix). Moreover, some observations made by the Coast Survey during the past year, being compared with others of previous years, indicate that in the portion of Cape Cod Bay, adjacent to the neighborhood under examination, there is a meeting of very peculiar coast currents, bearing material for shoal-building.

The Board, after carefully considering all the possibilities of the case by the light of the recent surveys and studies of its engineers, saw no sufficient reason to change the opinion, expressed in the report of last year, "that what has occurred must be mainly attributed to the dike." An order was therefore issued directing the removal of the accumulation, or so much of it as may be necessary to secure a channel for the passage of boats and small vessels.

The channel referred to, in the order which follows, was located upon the most recent survey in such a manner as to require the least excavation,—as far as such an economical consideration was consistent with the main purpose of the work. Within the pathway of this channel, three shoal places occur where the surface of the bottom is at, and above, the plane of mean low water. The first, or larger shoal, is within the harbor basin and above Washburn's Point, and makes a channel bar of about 600 feet in length, ranging from 0, on the low-water plane, to 1.6 feet above it. The second shoal is opposite Washburn's Point, and forms a channel bar of about 200 feet in length, ranging from 0 to 0.8 feet above. The third shoal is about half-way between Washburn's Point and the outer harbor line of the main shoal, and forms a channel bar of about 75 feet in length, at about 0, or low water plane. The area contained within the lines of the prescribed channel referred to is about eight acres, and while the maximum shoaling is 1.6 feet, the average over the whole channel will amount to about 10 inches.

The statute provides that if the proprietors fail to remove the obstructions as required within six months after due notice, the Harbor Commissioners shall cause the same to be removed at the expense of the said proprietors.

There is no fund from which this Board could pay for such a removal until reimbursement could be obtained from the proprietors, and it is not probable that any contracts could be made with payments contingent upon recovery from the proprietors; and thus for all practical purposes the power of the Board is exhausted in giving the notice unless further provision is made. What effect a failure of the proprietors to comply with the notice will have upon the legality of the structure can only be tested in the courts.

COMMONWEALTH OF MASSACHUSETTS.

HARBOR COMMISSIONERS' OFFICE, 8 PEMBERTON SQUARE,
BOSTON, September 13, 1876.

To the Proprietors of Green Harbor Marsh, mentioned in Section four of Chapter three hundred and three of the Acts of the year eighteen hundred and seventy-one.

Whereas, The proprietors of Green Harbor Marsh, in the town of Marshfield, were by the provisions of chapter 303 of the Acts of the year 1871, authorized to erect a dam and dikes across Green Harbor River at or near and not above Turkey Point, so called, with one or more sluice-ways and gates for the purpose of draining Green Harbor Marsh and improving the same, and preventing flowage from the sea; and

Whereas, The said proprietors did, under the authority of the said Act, erect a dam and dikes across said Green Harbor River, at the place and for the purposes contemplated and provided for in said Act; and

Whereas, By the fourth section of the said Act, it was provided, that should shoaling take place above the level of mean low water in the channel of Green Harbor River, and its approaches below the dam and dikes in consequence of the construction of said dam and dikes, said shoaling shall be removed by the proprietors of Green Harbor Marsh under the direction and to the acceptance of the Board of Harbor Commissioners; and

Whereas, The undersigned, the Harbor Commissioners mentioned in and intended by said Act, upon a full hearing and an inspection and examination of said dam and dikes and said river, do find and determine, that shoaling has taken place above the level of mean low water in the channel of said Green Harbor River and its approaches, below the dam and dikes erected as aforesaid in consequence of the construction of said dam and dikes;

NOW, THEREFORE, you are hereby notified and required to remove said shoaling and obstructions from the channel of Green Harbor River and its approaches, and in doing so you will be governed by the following directions, to wit:—

The obstructions of sands above the level of mean low water lying within the following prescribed lines, shall be removed:

The easterly and northerly line shall begin at a point in the line of mean low water, on the southerly side of said river, about midway between the easterly and westerly high-water shores thereof, and distant about 300 feet southerly from the southerly point of the marsh island next above it, and shall follow the general course of the present low-water channel south-easterly to the foot of the strand, or bank left bare at low water, on the easterly side of said river, distant 80 feet from a salient point in the high-water line thereof; thence following the general curve of the shore along the foot of the strand, in a southerly, south-westerly and south-easterly direction, around the point of beach which forms the south-easterly point, or headland of Green Harbor, at distances varying from 50 to 80 feet from the high-water line of said point of beach; thence, still following the general trend of the foot of the strand, at distances varying from 160, 150, 230 and 330 feet (at Bluefish Rock) from the high-water line to the low-water line of the main shore. The westerly and southerly line shall run from the point of beginning in the low-water line of said Green Harbor, parallel to the above described easterly and northerly line and distant from it 100 feet for a distance of 1,550 feet; thence the line shall run straight in a southerly and little easterly direction, for a distance of about 700 feet to a point in the low-water line of the main shore, distant 500 feet south-westerly from the end of the first-described line.

The space enclosed within the above-described lines is shown in red color upon a plan of said harbor on file in the office of this Board, entitled " A Map of Green Harbor, Mass., showing the channel and its approaches at mean low water."

Or an excavation in the channel of said river and its approaches to the level of mean low water having a width of not less than 100 feet from the harbor basin to past the headlands of the same, having a width of not less than 500 feet at the low-water line of the main shore, may be made, following any other course from the point of beginning, before mentioned, to the sea, satisfactory to this Board.

The level of mean low water is referred to the following described bench-marks:

Bench-mark A is situated on the top of the smaller and more northerly of two bowlders in the marsh, situated 70 feet N. N. W. from a bridge over a creek in said marsh, and is also 245 feet S. S. E. from the chimney of Mr. Thomas Keith's house, and is marked by two cuts in the rock, thus, Λ. The height of this bench-mark above the level of mean low water, is 10.740 feet.

Bench-mark B is situated on the top of Bluefish Rock, 74 feet N.

E. of the highest point of said rock, and is marked by three cuts in the rock, thus, ∴. The height of this bench-mark above the level of mean low water, is 18.260 feet.

GLOUCESTER.

The rapid development of the fisheries and kindred interests at Gloucester, during the past ten years, has given to this port peculiar importance among our commercial stations.

This harbor, called by Champlain, who visited it in 1606, *Le Beau-port*, has sustained its good name. No diminution of depth has taken place at its entrance, and none within the roadstead as far up, certainly, as Rocky Neck. Opening to the south-westward without actual obstruction in the approach, "this port," as Champlain reported, "is very fine and good,—having enough water for ships, and shelter behind the islands." According to the Annual Report of the Coast Survey for 1869, the roadstead has anchorage-room for 327 miscellaneous vessels riding freely at anchor, and an extreme exposure of 28½ miles.

The "shelter behind the islands" is, however, quite inadequate for the great fleets of fishing and merchant vessels that now resort to this harbor; and, while it must be admitted that well-found vessels may safely ride out heavy gales in portions of the roadstead, it often happens at such times that the best locations are overcrowded. General John G. Foster, in his report to the engineer-in-chief of the United States, dated January 20, 1871, "after a careful consideration of the whole subject," proposed that a breakwater should be built, connecting Dog Bar and Rock Shoal with Eastern Point. Shelter of this kind would permit vessels to moor closely without danger of mutual injury, and thus practically enlarge the capacity of the roadstead. It would also extend the frontage suitable for wharves, etc. No appropriation has ever been made for this breakwater. In fact, the only money expended by the general government in the improvement of this harbor, within the knowledge of the Board, is the sum of $10,000, successfully used by General George Thom in blasting out rocks or lifting bowlders from the Upper Harbor and its approach.

The Inner Harbor, upon which the city is situated, has an ample depth in its contracted channel-way, but the shores are so flat and rocky that difficulties present themselves in the construction of landings which only a very energetic and prosperous community could have overcome. The study and approval of plans for building wharves at Gloucester, were among the earliest duties of the Board, and in assisting to reconcile conflicting claims upon the flats that lay in front of riparian proprietorships, the Board has generally expressed its judgment after a careful consideration, and met a cheerful acquiescence from a class of busy men, who desired only their just proportions without recourse to legal proceedings.

During the past year, which has witnessed less activity in all other ports, as far as the offices of this Board extend, the calls for licenses to build wharves at Gloucester have exceeded in number those of any previous year, and have involved less conflict among the applicants and their neighbors than might have been expected in so crowded a place. The following information concerning the commerce and fisheries of this port is kindly supplied by Mr. F. T. Babson, United States collector:—

Tonnage of district, 1868, ...	26,100 tons.
Number of vessels, 1868,.	529
Tonnage of district, 1876, ...	34,580 tons.
Number of vessels, 1876, ...	522
Value of fisheries, 1869, ...	$3,600,000
Value of fisheries, 1875, ...	4,600,000

Imports increased 100 per cent. in ten years.

Foreign arrivals increased 100 per cent. in ten years.

One hundred and twenty-five thousand hhds. of salt were imported last year in 45 vessels; tonnage, from 300 to 900 tons burden.

The trade with Nova Scotia and Canada remains about the same as in 1867. "A very large number of vessels, other than our own," says Mr. Babson, "make our harbor a place of refuge. Our boarding-officer estimates them at 3,000." "A large number of vessels from foreign countries touch here for orders; 5,140 have been boarded."

PROPOSED INLET AT OSTERVILLE.

A short time before the harbor committee of the Legislature of last year closed its hearings, the Board was requested to examine the project for an opening through the narrow beach that separates the South Bay of the Cotuit lagoons from Nantucket Sound.

The parties petitioning for the privilege of making this cut, proposed to do the work at their own expense, and no objection would probably have been made by the committee had there been no remonstrants. These remonstrants represented that the entrance to Cotuit Port would probably be injured by the creation of a new outlet, not only because the flow of the tide through the present entrance would thus be reduced, but also because the currents along the outside beach and bar of Cotuit would be changed.

An inspection instituted by the Board, seemed to warrant the conclusion that the cut, if successfully made and maintained, would reduce the flowage over Cotuit Bar, and tend to reduce the depth in something like the same proportion, but that no essential change in the currents along the outside coast would occur.

Without a regular gauging of the tides in the lagoons, the amount of injury to the present entrance, which the creation of another opening would cause, cannot be estimated closely.

PROVINCETOWN HARBOR.

The attention of the Board has been called, by the petition of parties for leave to extend wharf structures into the harbor from Long Point, to the expediency of modifying so much of the harbor line as defines the frontage of this part of the harbor, for the reason that as the harbor line is now, wharf structures cannot be extended to a depth of water suitable for commercial purposes.

It is the opinion of the Board that this part of the present harbor line can be so modified as to conserve the harbor, and at the same time admit of the extension of wharves into a depth of water sufficient to float, at their sides and ends, such vessels as are employed in the commerce of the port.

The Board will submit, at such time in the session as the

Legislature may assign for its consideration, plans for the change of harbor line proposed.

EAST HARBOR.

In pursuance of the conditions of chapter 34 of the Acts of 1874, settlement has been made with the marsh owners at East Harbor. The number of proprietors whose rights in these marshes have been bought out by the Commonwealth, is 58, and the total amount paid in settlement of the same, and for expenses, up to January 1, 1877, is $9,756.46.

A list of the names of the proprietors will be found in the Appendix.

RE-SURVEY OF THE WHARF LINES OF BOSTON UPPER HARBOR.

In the experience of the Board, in dealing with questions of change and improvement in the frontage of the Upper Harbor, submitted by the Legislature and by corporations and individuals, the need for a new survey has been manifest for several years.

The last accurate survey which can be relied upon for the constantly required data necessary for the action of the Board in properly locating, and safely guiding, the important works which are proposed and being executed, is that made at the instance of the United States Advisory Council, in 1860–61, by Mr. Albert Boschke, now sixteen and seventeen years ago.

As may be understood, the wharf lines of the Upper Harbor have undergone many changes, in detail and in general outline during this period of time, so that difficulties and uncertainties have consequently arisen, in referring new works and improvements to the older landmarks.

The Board is already vested with authority to make necessary surveys, but the proposed re-survey of the harbor frontage will involve more expenditure than can be made under the limited appropriation for the general current expenses of the Board. In connection with a re-survey, and based upon the data which it will furnish, the Board recommends the revival of the several harbor lines.

The present harbor lines are established by various and independent acts of the Legislature, based upon unconnected data, many of them dating back as far as *forty years*, and many of the original points of reference are lost by the obliteration of old landmarks. The lines should be referred to imperishable points, and to triangulation bases without the city, so that they can be reproduced with perfect accuracy.

The Board submits the following estimate for the proposed survey :—

For triangulation, based upon the data of the Coast Survey, ...	$1,000 00
For detailed linear survey of wharf lines, etc., . .	3,000 00
For accompanying hydrography in determining the depth of docks and slips, and the immediate wharf frontage, ...	1,000 00
	$5,000 00

REVENUE RECEIVED FROM TIDE-LANDS OF THE COMMONWEALTH.

In former times it had been the custom of the Legislature to grant the right to occupy tide-lands without compensation; but it seemed to the Board that, in localities of commercial importance, the tide-lands had a value relative to the value of the adjacent upland, and that some compensation for such tide lands should be made to the Commonwealth in addition to the compensation for tide-water displaced by structures erected upon them; and at the instance of the Board, chapter 284 of the Acts of 1874 was passed.

Since that time, and up to January 1, 1877, the revenue received by the Commonwealth through licenses granted by the Board, has amounted in total to the sum of $25,233.41.

This money does not go to the compensation fund for the improvement of Boston Harbor, but to the sinking fund for the payment of the war debt.

COMPENSATION FUND FOR BOSTON HARBOR.

The following amount represents the Compensation Fund for Boston Harbor, up to January 1, 1877, $124,903.90.

To cover works of improvement in the harbor desirable to be carried forward, the Board recommends the appropriation of the income from the compensation fund for the current year.

HARBOR IMPROVEMENTS BY THE GENERAL GOVERNMENT.

In our first report, dated January, 1867, will be found a copy of the earnest petition which the Board, immediately after its organization, carried to Washington and laid before Congress, under the authority given by the Legislature, soliciting appropriations for the improvement and protection of the channels of Boston Harbor. Of the twelve items enumerated in that first petition, eight have received due attention, besides several others which were added by the Board, or suggested as incidental by the United States engineer in charge; and while it is to be hoped that the general government will not relax its hand till all be accomplished, it must be frankly and gratefully admitted that the heaviest ships that traverse the ocean may now seek any portion of our *four thousand acres of sheltered anchorage* without danger, and almost without the *fear* of danger. At some critical points, a vessel must still alter her course abruptly to avoid hidden rocks, but we have every reason to believe that the entire removal of these rocks will be provided for, the United States engineer in charge having made the practicability and advantage of these improvements so clear to the minds of all.

The principal dangers that ten years ago beset the entrances of Boston Harbor, by way of Broad Sound, and by way of the Narrows,—dangers that taxed to the utmost the skill of our pilots and prejudiced the reputation of the port, are gone.

In the Broad Sound entrance, there stood a rock rising within four feet of the surface at low water. Its name, "Barrel," indicated its supposed diminutive form, but there being no sign of its whereabouts, except a buoy often misplaced by sea and ice, it was a formidable danger to the vessels trading with eastern ports. It is a curious fact that this enemy at the gate, long feared and long tolerated, was blown to pieces and carried off by General Foster at an expense of but $6,000.

In the approach to the Narrows, while the vessel is still in the sea-way, she has to pass several reefs and ledges, one of which, "Kelly's Rock," lies in what would be her direct course if she did not turn aside to avoid it, and by this turn pass near other dangers. This rock, or group of rocks (as it proved to be), had a minimum depth of 16 feet. General Foster, and subsequently General Thom, attacked it, and now, although the work is incomplete, there are 19½ feet clear, and but $11,300 are deemed necessary to remove everything above the plane of 23 feet at low water.

In the Narrows there were two very contracted passes,—one between George's Island and Great Brewster Bar, the other between Lovell's and Gallop's islands. In the first of these lay two rocks, which were so much feared that heavy vessels, arriving at low water, preferred to wait for the tide, rather than venture to pass them when covered with less than their own draught of water. At this place the avenue for heavy vessels at low-water was scarcely 250 feet wide, and there was every reason to believe that if Brewster Bar continued to advance at the rate it had been doing, this channel would be closed within a century.

Under General Foster's direction the two rocks were blasted out, and under General Thom's direction, Brewster Spit and its underlying ledge were cut off; so that now the 23 feet low-water channel is 600 feet wide, and vessels may stand quite up to the Brewster Spit without fear.

The other contraction between Lovell's and Gallop's islands has been widened under the same officers to nearly 600 feet.

A rock in the middle of a channel, even when visible, reduces the beating-room of a vessel more than one-half, and when hidden, occupies in effect a much greater space, because of the uncertainty of its location. Much in the same way a hidden shoal, or extending flat, takes exaggerated dimensions in the fears of the navigator, and cramps his manœuvres unduly. The result of these improvements is, that the Main Ship Channel is, *in effect*, five times as wide as it was ten years ago.

In the approach to the Upper Harbor, the channel between the Lower Middle and Castle Island, although of ample depth, is very narrow, and vessels have to hug the shoal to keep in the best water. It was near this critical pass that

"State" and "Palmyra" rocks projected from the margin of the shoal, and occasioned disaster. These obstacles have been blasted away to the surface of the adjacent bottom.

In the original project of the Board relative to the Upper Middle Bar, which obstructed the approach to the city of Boston, the desirable width of the channel to be dredged was placed at 1,000 feet; the general government, however, for military reasons, restricted it to 600, and this width has been nearly achieved. There remains only 81½ cubic yards of rock to be blasted out. The rock referred to is a ledge projecting about 150 feet into the new channel, and has now upon it 20 feet of water at low tide. Except the removal of the rocks from the Narrows, this cut through the Upper Middle Bar is the most important and the most appreciated improvement that the harbor has received at the hands of the general government; and it is because of the great benefit already derived from this work, that the Board is disposed to recall the attention of government to the original solicitation for a channel 1,000 feet in width.

As peace, not war, is the normal condition of our country, those purposes which belong to peace and make its preservation dear to all, should, we submit, have precedence; and therefore we trust, with returning faith in the permanence of peace, Congress may be willing to give us the broader channel which has been asked, even if forts must be strengthened and heavier guns provided. The Commonwealth, in the project for reclaiming South Boston Flats, has inaugurated a work which provides for widening the channel above this bar to twice the width deemed essential at the bar itself, or more than three times the width Congress provides for.

The Board proposes to communicate with Maj. Gen. Humphreys, the engineer-in-chief, concerning this matter, before renewing its petition to Congress.

Congress so far listened to the prayers of the Board, last winter, as to provide for a survey of Man-of-War Shoal, which obstructs the passage-way to the navy yard and other valuable frontages of the harbor. We entertain no doubt that the engineer to whom is assigned the execution of this survey, will recognize the advantage both to the naval and mercantile marine, of the entire removal of this shoal.

The Board is indebted to General Thom for the cordial manner in which he has responded to all calls for information; and likewise to Mr. H. F. Bothfeld, the able assistant engineer, who has been, from the first, in immediate charge of the details of the works in Boston Harbor upon which we have commented. The following notices of improvements at Hingham and Plymouth harbors, and in Merrimac River, are mostly based upon Gen. Thom's notes, which appear in full in the Appendix.

Hingham Harbor.

General Thom announces the completion of the channel up to Hingham "so as to have a width not less than 100 feet, and a depth of eight feet at mean low water." The cost of this improvement was not to exceed $10,000, and the contract for dredging having been made at the exceedingly low rate of 18 cents per cubic yard, there can be no doubt the money's worth of real advantage has been gained.

Plymouth Harbor.

In last year's report, mention was made of a contract made by General Thom for excavations in Plymouth Harbor. This contract was made at a low rate, and yet so successfully carried out, that there is now a channel 50 feet wide and six feet deep at mean low water, from the deep water near the Middle Ground to the wharves of the town. General Thom's plan is for a channel of double the width stated above, and for the rest of the work he has submitted his estimates.

In the Appendix will be found a report to the Superintendent of the United States Coast Survey, relative to the physical history of the Main Entrance Channel and bay of Plymouth, to which reference has already been made in the remarks on Green Harbor River.

Merrimac River.

"The project adopted for this river consists in so improving it by dredging and the removal of sunken rocks, that it shall have a depth of twelve feet at ordinary high water, from its mouth in Newburyport Harbor to Haverhill (a distance of fifteen miles), and thence for a distance of about four miles up through the falls a depth of four feet in the ordinary stages of the river." This project requires now for its completion only the removal of numerous sunken bowlders from the channel near Silby's Island and elsewhere, for which there are presumed to be funds enough in the engineer's hands.

New Bedford Harbor.

The project of improvement in this harbor was the excavation of a channel 200 feet wide from the deep water near Fairhaven across the shoal to the wharves of New Bedford.

There has been actually dredged a channel 105 feet wide and 15 feet deep at low water; and, according to General Geo. K. Warren, the United States engineer in charge, only $4,000 is now required to complete the work.

Wareham River.

The scheme of improvement for this harbor was completed in July. It provides a channel with nine feet of water at mean low tide, 100 feet wide at the narrowest place, and over 200 feet for the most part. This work has been also executed under direction of General Warren.

Taunton River.

General Warren reports that the channel is now essentially nine feet deep at mean high water, and nowhere less than 45 feet wide. There remains yet the removal of shoals and scattering rocks, mainly from the lower part of the river.

Fall River.

The original project for improving this river contemplated a gradual widening out of the new channel to 300 feet at each end through a curved part of its course. General Warren reports that a channel to the depth of twelve feet at mean low water, 100 feet, has been completed.

Further details relative to works under the direction of General Warren, will be found in the notes which he has kindly furnished, in the Appendix.

OFFICE AND FIELD WORK.

The office and field works incident to the acts and orders of the Board have been fully up to the average of former years, and have included the usual examination of plans submitted, the plotting of field notes, and the preparation of maps and sketches.

Field examinations and surveys have been made whenever the work or supervision of the Board required such data.

Special hydrographic surveys have been made in Boston Harbor, in connection with the dredging operations there, under the direction of the Board. A special survey was also made of Green Harbor River, in Marshfield, which is more particularly mentioned in another part of the report.

The Board, with their engineers, have visited such harbors and localities on the coast of the Commonwealth, and have given such hearings and investigations as the subjects and localities required.

The following details are given in the form usually submitted:—

Plans approved by the Board of Harbor Commissioners during the year 1876, for the erection of structures in or over tide-water, and licenses granted for such structures.

1. E. J. M. Hale, for leave to build a wharf in Merrimac River, at Groveland. Approved January 5, 1876.

2. Cambridge Improvement Company, for leave to fill a parcel of flats in Charles River, on the northerly side of Broad Canal, Cambridge. Approved February 2, 1876.

3. John Atkins, for leave to construct a pile wharf in Provincetown Harbor. Approved February 9, 1876.

4. Mark Googins and Albert Bowker, for leave to extend their wharf on Border Street, East Boston. Approved February 23, 1876.

5. William C. Brooks & Co., for leave to fill solid a part of their dock in Miller's River, Cambridge. Approved February 16, 1876.

6. Fitchburg Railroad Co., for leave to widen its passenger bridge crossing Charles River, on the westerly side. Approved March 15, 1876.

7. Fitchburg Railroad Co., for leave to widen its passenger bridge crossing Charles River, on the easterly side. Approved March 15, 1876.

8. Perez Cushing, for leave to extend his wharf on First Street, South Boston. Approved March 22, 1876.

9. South Boston Gas Light Co., for leave to extend its wharf on piles on First Street, South Boston. Approved March 29, 1876.

10. Peter M. Neal, for leave to extend his wharf on Beach Street, Lynn Harbor. Approved April 19, 1876.

11. Old Colony Railroad Co., for leave to build a pile bridge across Monument River, in the town of Sandwich. Approved April 26, 1876.

12. William Darton, for leave to extend his wharf on Border Street, East Boston. Approved April 26, 1876.

13. Lincoln Wharf Co., for leave to extend Lincoln's wharf in Boston Harbor. Approved May 3, 1876.

14. Caroline A. Breed, for leave to extend her wharf in Lynn Harbor, and also to dredge a channel. Approved May 17, 1876.

15. William G. Brown, for leave to extend his wharf in Ipswich River, at Ipswich. Approved May 24, 1876.

16. Charles S. Clark, for leave to change the line of sea-wall in the extension of his wharf on South River, Salem Harbor. Approved May 24, 1876.

17. City of Boston, for leave to repair and enlarge the draw-pier in Malden Bridge over Mystic River. Approved May 31, 1876.

18. The Boston, Winthrop & Point Shirley Railroad Co., for leave to construct a pile bridge in the location of its road across Belle Isle Creek, between Boston and Winthrop. Approved June 1, 1876.

19. The cities of Cambridge and Somerville, for leave to extend the outlet of the Bridge Street sewer under Cragie Bridge, in Charles River. Approved June 1, 1876.

20. George Douglas, for leave to build a pile structure for the accommodation of a ferry-boat at East Gloucester. Approved June 1, 1876.

21. Joseph O. Procter, for leave to extend his wharf on piles in Gloucester Harbor to the Commissioners' line. Approved June 14, 1876.

22. Smith and Oakes, for leave to extend their wharf on piles in Gloucester Harbor to the Commissioners' line. Approved June 14, 1876.

23. Cunningham and Thompson, for leave to extend their wharf on piles in Gloucester Harbor to the Commissioners' line. Approved June 14, 1876.

24. Swett & Co., for leave to extend their wharf on piles in Gloucester Harbor to the Commissioners' line. Approved June 14, 1876.

25. Town of Westport, for leave to construct a bridge over Westport River to Horseneck Beach. Approved June 21, 1876.

26. George Steele, for leave to extend his wharf to the Commissioners' line on piles in Gloucester Harbor. Approved June 21, 1876.

27. William H. Friend, for leave to extend his wharf in Gloucester Harbor on piles. Approved June 21, 1876.

28. City of Boston, for leave to repair, reconstruct and widen Dover Street Bridge. Approved June 21, 1876.

29. George F. Weston and Edward Harlow, for leave to extend their wharf in Plymouth Harbor. Approved July 5, 1876.

30. Dorchester Gas Light Co., for leave to build a wharf and dredge a channel on its land or flats between Savin Hill and Commercial Point. Approved July 5, 1876.

31. The Fall River Iron Works Co., for leave to extend its wharves in Taunton Great River at Fall River. Approved August 2, 1876.

32. Richard Borden Manufacturing Co., for leave to extend its wharf in Taunton Great River at Fall River. Approved August 2, 1876.

33. William H. Wonson & Sons, for leave to extend their wharf in Gloucester Harbor on piles to the Commissioners' line. Approved September 6, 1876.

34. Commissioners on Prison Point Bridge, for leave to rebuild Prison Point Bridge, between Cambridge and Charlestown District, across Miller's River. Approved September 20, 1876.*

35. Roxbury Gas Light Co., for leave to fill flats in South Bay bordering on Roxbury Canal. Approved September 27, 1876.

36. Orraz A. Taft, for leave to build a pile wharf at Point Shirley, Winthrop. Approved October 18, 1876.

37. David Low & Co., for leave to extend their wharf on piles in Gloucester Harbor. Approved October 25, 1876.

38. Samuel R. Lane, for leave to extend his wharf on piles in Gloucester Harbor. Approved October 25, 1876.

39. Amos A. Story, for leave to fill solid a portion of his wharf in Gloucester Harbor. Approved November 1, 1876.

40. Committee on streets of the city of Boston, in relation to the laying out of Eastern Avenue as far as E Street extended. Approved November 1, 1876.

41. Boston & Lowell Railroad Corporation, for leave to cover with a pile structure the space lying between its freight bridge and

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* This bridge has just been completed and opened for public travel, making the last draw of 36 feet, constructed in conformity with the Act of 1870 as to the width of the draws on Charles and Miller's rivers.

wharf in Charles River at East Cambridge. Approved November 15, 1876.

42. City of Boston, for leave to build an abutment-wall and fill solid a parcel of flats now covered in part by Chelsea Bridge on the Charlestown side. Approved November 15, 1876.

43. James Mansfield & Sons and Charles H. Boynton, for leave to dredge a channel from their wharves in Harbor Cove, Gloucester Harbor. Approved November 15, 1876.

44. Heirs of William McKenzie, for leave to extend their wharf to the Commissioners' line on piles, in Gloucester Harbor. Approved November 22, 1876.

45. John G. Bennett, for leave to extend his wharf to the Commissioners' line on piles, in Gloucester Harbor. Approved November 22, 1876.

46. Old Colony Railroad Co., for leave to extend its draw-pier in its bridge across Fort Point Channel. Approved November 29, 1876.

Hearings before the Board in addition to the regular Business Meetings.

One hearing with land-owners of East Harbor, Provincetown, in relation to damages done to the meadows by the construction of the state dike across East Harbor.

Two hearings with citizens of Sandwich, in relation to the construction of a draw in the bridge of the Old Colony Railroad Company across Monument River.

Two hearings with parties who have been engaged in illegal filling of flats in Prison Point Bay, Charlestown District.

One hearing on the petition of the Cambridge Improvement Company, for leave to build temporary wharf accommodation during the progress of the work in Charles River, Cambridge.

One hearing on the petition of Albert Bowker and Mark Googins, for leave to extend their wharf on Border Street, East Boston, and to be relieved from paying compensation for tide-water displaced by said extension.

One hearing on the petition of the Fitchburg Railroad Company, for leave to widen its bridge over Charles River on both sides, and the proposed taking of land therefor covered by tide-water.

One hearing on the petition of William C. Brooks & Co., for leave to fill solid a portion of their dock in Miller's River, East Cambridge.

One hearing on the petition of Nash, Spalding & Co., in relation to widening and reconstructing the draw in Prison Point Bridge over Miller's River, by the cities of Cambridge and Boston.

One hearing with Bridge Commissioners on Cragie Bridge, on the petition of the cities of Cambridge and Somerville, for leave to extend Bridge Street sewer under Cragie Bridge to deep water.

Two hearings on the petition of Caleb H. Dolbeare, asking to be relieved from paying compensation for tide-water displaced by wharf extension in Fort Point Channel.

One hearing on the petition of William Darton, for leave to extend his wharf on Border Street, East Boston.

Three hearings on the petition of Charles H. Lewis, for extra compensation for dredging, under his contract for dredging shoals in Boston Upper Harbor.

One hearing on the petition of the town of Westport, for leave to construct a bridge from Westport Point to Horseneck Beach.

One hearing on the petition of H. Barker & Co., asking to be relieved from paying compensation for tide-water displaced by wharf structure in Charles River, near Watertown, on account of dredging from the bed of the river, to an amount equal to the amount of filling.

Two hearings on the petition of William H. Friend, for leave to extend his wharf in Gloucester Harbor.

Two hearings on the petition of the Boston, Revere Beach & Lynn Railroad Company, for license to fill two creeks on the line of its road, in the town of Revere.

Two hearings on the petition of the Eastern Railroad Company, in relation to the draw-pier built by the city of Newburyport in the bridge over Merrimac River under license of the Board.

Three hearings on the petition of E. B. Phillips, for leave to construct a plank walk on "Wales Beach," in the town of Swampscott.

One hearing on the petition of J. B. Lamper, for leave to build a pile wharf in Lynn Harbor.

One hearing on the petition of Boynton Brothers, for payment on account of dredging off Battery Wharf.

One hearing on the petition of the Roxbury Gas Light Company, for leave to build bulkheads and fill flats, etc., in South Bay, near Roxbury Canal.

Two hearings on information of Captain Cates, harbor-master of Boston, in regard to unlawful dumping of material in the channels of Boston Harbor.

Two hearings on the petition of the Cambridge Improvement Company, in regard to alleged illegal filling by the city of Cambridge, within the territory covered by their license from the Board.

Two hearings on the petition of Samuel R. Lane, for leave to extend his wharf in Gloucester Harbor.

One hearing on the petition of O. A. Taft, for leave to build a wharf at Point Shirley, in the town of Winthrop.

One hearing on the petition of Amos A. Story, for leave to fill solid a portion under his present pile wharf in Gloucester Harbor.

One hearing on the petition of James Mansfield & Sons et als., for leave to dredge a channel from their wharves in Harbor Cove to the present channel in Gloucester Harbor.

Six hearings with the contractors for the work on South Boston Flats in regard to the progress for the work.

Field Surveys.

Survey in Merrimac River, in regard to the location of a wharf structure by E. J. M. Hale of Groveland.

Three surveys off Battery Wharf, for the purpose of ascertaining amount of material dredged as per contract, and plans made thereof.

Inspection of Cotuit Harbor and South Bay, at the request of the legislative committee on harbors, in regard to a proposed inlet from the Sound to South Bay, and plans made thereof.

Survey off Chelsea Ferry, for the purpose of ascertaining amount of material dredged as per contract, and plans made thereof.

Survey off the National Dock and Warehouse Company's wharves at East Boston, for the purpose of the removal of a shoal in front of said wharves by dredging, and plans made thereof.

Survey of Green Harbor River, Marshfield, for the purpose of ascertaining alleged shoaling of Green Harbor, on account of the dike built by certain marsh-owners, under chapter 303 of the Acts of the year 1871, and plans made thereof.

Surveys on Charles and Miller's rivers, to ascertain amount of filling done by the Boston and Lowell Railroad Corporation.

Surveys in Boston Inner Harbor, including Chelsea Creek, Mystic River, Charles River, Fort Point Channel, South Bay, and Neponset River, for the purpose of mapping the different wharf and bridge structures built since 1861.

Survey in East Cambridge, for the purpose of establishing low-water mark near the Boston & Lowell Railroad freight bridge, and plan made thereof.

Survey in front of the Grand Junction and Cunard wharves, East Boston, for the proposed removal of shoals in front of said wharves, as petitioned for by the Boston & Albany Railroad Company and the Cunard Steamship Company, and plans made thereof.

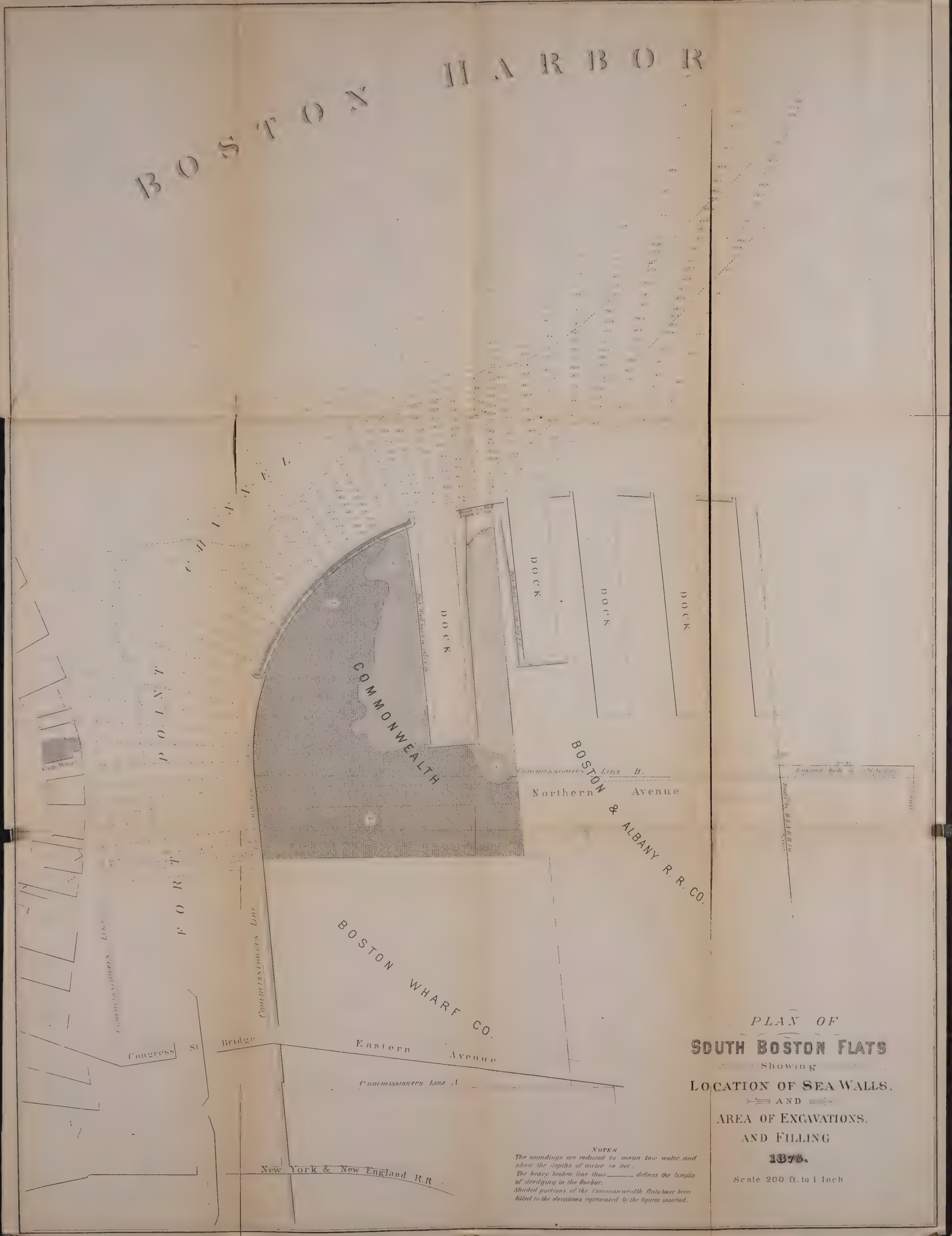
Survey in Boston Harbor, for the purpose of locating the powder boats of the Oriental Powder Company.

Surveys made of all structures in tide-water in Boston Harbor wherever compensation for tide-water displaced is assessed.

In addition to the work enumerated, which formally, and at regular business meetings, received the official sanction of the Board, there is almost daily intercourse with those who visit our rooms for investigation and inspection. During the last ten years, a large collection of maps and plans has accumulated of structures already completed in tide-water, which is of much importance to those who contemplate similar improvements, either in the same or other localities. Plans of sea-walls, bridges, wharves (solid or on piles), and works of a kindred character, conveniently filed, are freely accessible to any citizen of the Commonwealth, and our engineers cheerfully give any information which is required.

Our relations with the United States authorities in the Department of Engineers and in the Coast Survey, have been of an agreeable character and of great advantage to the interests we have in charge. We would also acknowledge the services of Mr. D. Koppmann, the long-tried and faithful assistant to the Board, and the acceptable aid of Mr. William T. Blunt, temporarily employed on surveys and plans.

JOSIAH QUINCY,
FREDERIC W. LINCOLN,
J. N. MARSHALL,
WM. T. GRAMMER,
ALBERT MASON,
Board of Harbor Commissioners.



PLAN OF

SOUTH BOSTON FLATS

Showing

LOCATION OF SEA WALLS,

AND

AREA OF EXCAVATIONS,

AND FILLING

1876.

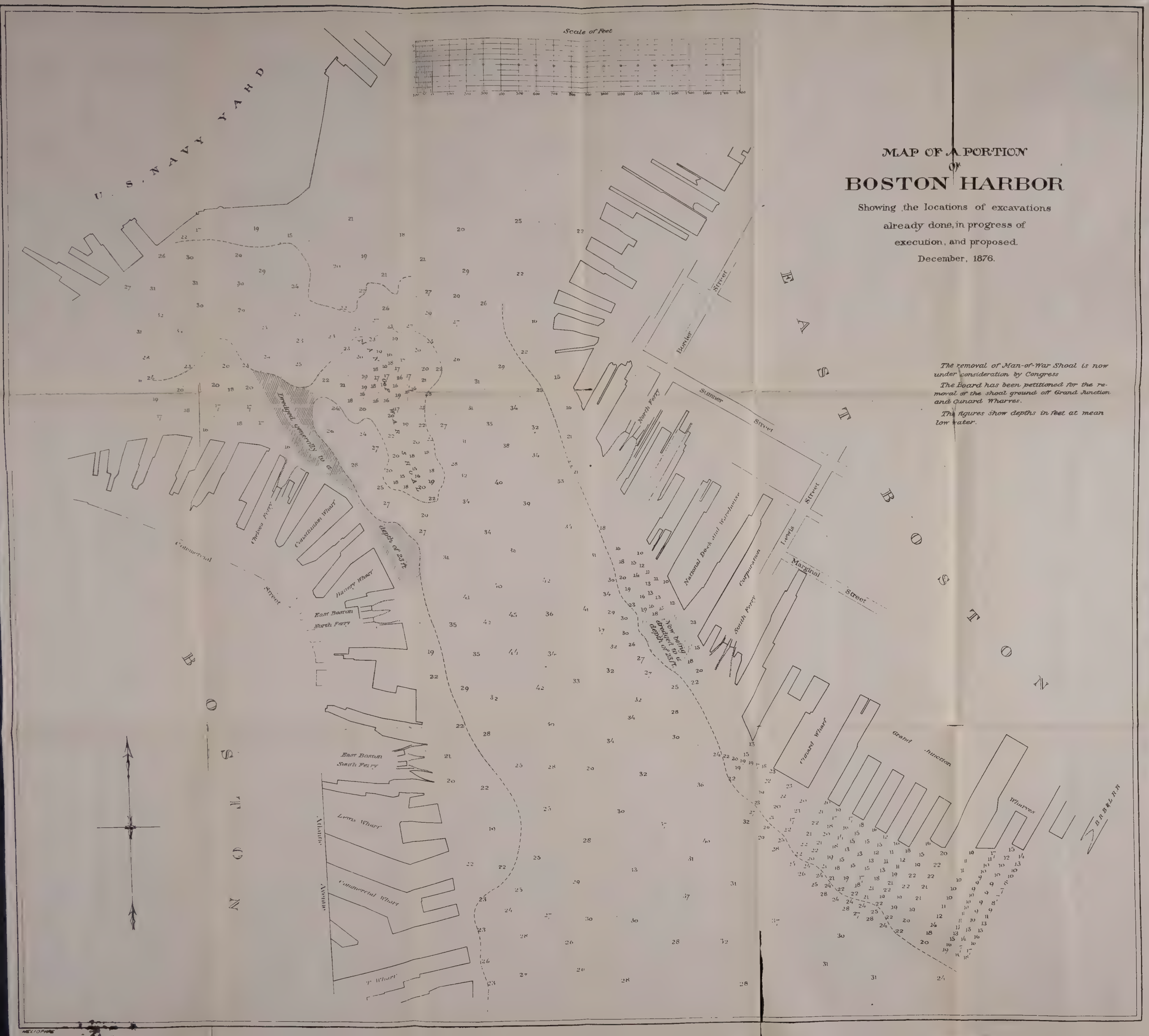
Scale 200 ft. to 1 Inch

NOTES

The soundings are reduced to mean low water, and show the depths of water in feet.

The heavy broken line thus ——— defines the limits of dredging in the Harbor.

Shaded portions of the Commonwealth flats have been filled to the elevations represented by the figures inserted.



MAP OF A PORTION
OF
BOSTON HARBOR

Showing the locations of excavations already done, in progress of execution, and proposed.

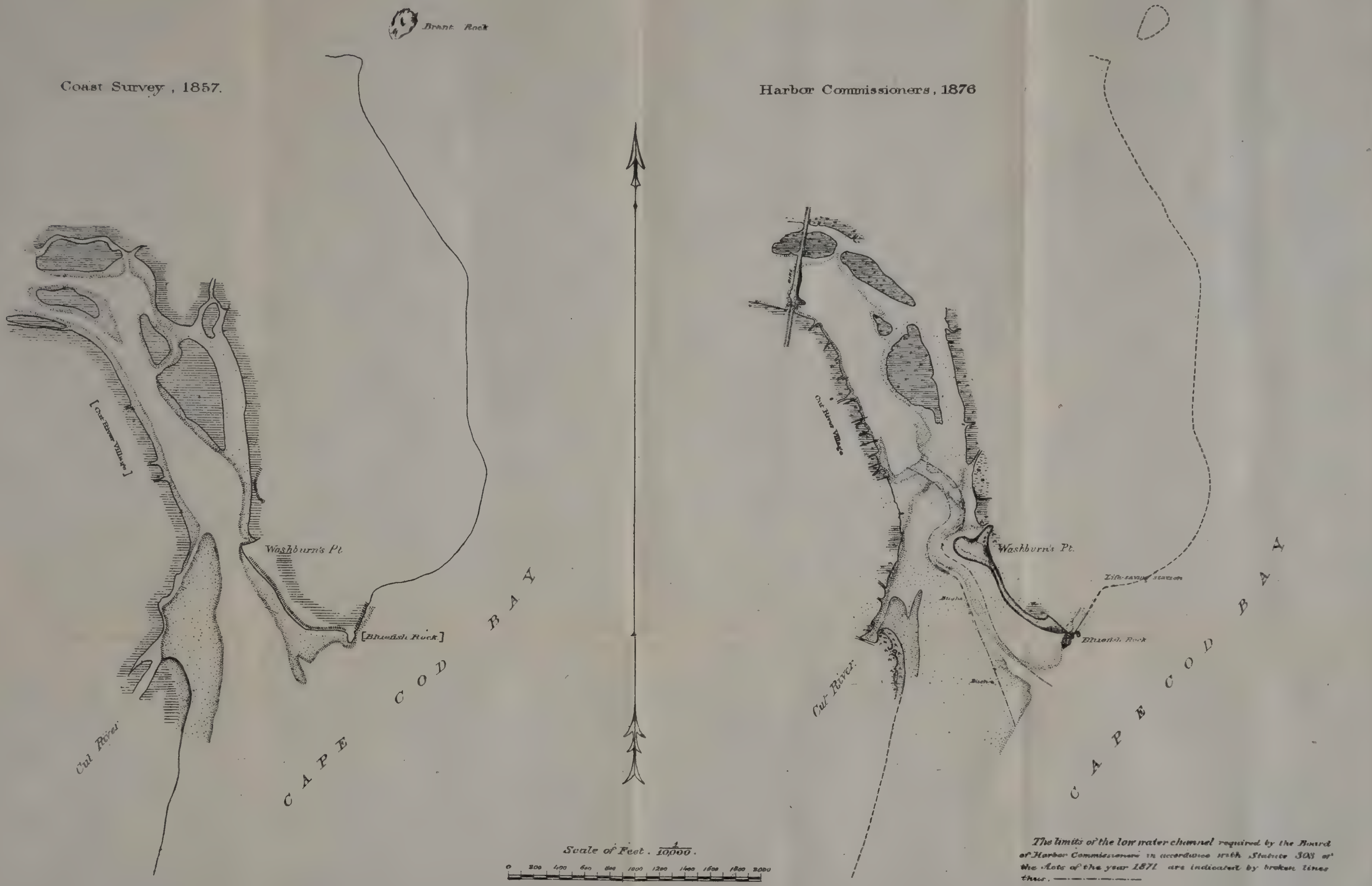
December, 1876.

The removal of Man-of-War Shoal is now under consideration by Congress

The Board has been petitioned for the removal of the shoal ground off Grand Junction and Cunard Wharves.

The figures show depths in feet at mean low water.

MOUTH OF
GREEN HARBOR RIVER
MASSACHUSETTS.
Scale $\frac{1}{10000}$.



The limits of the low water channel required by the Board of Harbor Commissioners in accordance with Statute 303 of the Acts of the year 1871 are indicated by broken lines thus. —·—·—·—·—·—

HELIOTYPE.

APPENDIX.

APPENDIX.

IMPROVEMENT OF SOUTH BOSTON FLATS.

Report of the Engineer in Charge, December 31, 1876.

During the past year the following progress has been made by the contractors, Messrs. Clapp & Ballou. The heavy wall has been essentially completed as far east as the first dock. The light wall around this dock is finished, except a short portion where it is to be built in connection with the heavy wall east of the dock, now in progress. The heavy wall between the docks is laid up to a height of fourteen feet from its foundation, its top being now seven feet below low water. The work is progressing whenever the weather permits, and will probably be laid up to low water as soon as the weather in the spring of 1877 allows the work to be prosecuted above that level, where cement is to be used.

The work of filling has been pushed about as fast as the walls were ready to receive it. All the wall west of the first dock has been loaded, even more heavily in some places than its final load, and stands well. The portion that was built upon rip-rap has settled an average of about six inches along its whole length, since it was begun, owing to the indentation of the rough stones into the clay bottom. An allowance was made for this in adjusting the coping, so that it still stands at grade sixteen. The settlement has been so uniform along its whole length that no cracks worth naming have been developed in the cement work.

In providing material for the filling, the dredging has been done as follows:—

Fort Point Channel has been dredged to the required depth, with slight exceptions, for a width of 400 feet opposite the light wall, reaching by a gradual slope a depth of 19 feet below low water at the beginning of the heavy wall. The channel then gradually contracts in width to about 200 feet before arriving at a point opposite the first dock, increasing in depth to 23 feet below low water. Near the entrance of the first dock it has been widened again to a width of 400 feet, to allow vessels to turn in entering or leaving the dock. From this point a channel is dredged about 200 feet wide and 23 feet deep at low water nearly due east to the main ship channel. A considerable amount of material has also been taken from the former shoal off Long Wharf. There now remains to be dredged from the first dock itself about 64,000 cubic yards, which, it is estimated, will about complete the clay filling of the 25 acres now contracted for.

Mention has been made in former reports of a timber platform to be built in front of the light walls along Fort Point Channel and the dock walls. Although such a platform was a part of the original plans, no contract has been made for its construction, it being considered as of little use until the property should be occupied for commercial purposes. But if the dock should be dredged to its full depth without building this platform, the mud and clay would be likely to slip away from the foundation piles of the wall and expose them to the attacks of the worms, which are quite destructive in these waters. The cost of building the platforms along both walls would be about $75,000. If it be thought unadvisable to do this work at present, or preferable to leave it to be done by the future occupants of the premises, the foundation of the wall would in the meantime be fully guarded by omitting some of the dredging along the front of the dock wall or by driving a row of spruce piles along the base of the dock wall and in its front. The latter would cost about $4,000.

The cost of the work now under contract during the successive years of its progress is given in the following tabular statement.

Respectfully submitted by
Your obedient servant,

EDW. S. PHILBRICK,
Engineer in Charge.

WORK DONE.	LINEAR FEET.		Square Feet Filling.	Total Value at Contract Prices.	Reserved under Contract.	Actually Paid.
	Light Wall.	Heavy Wall.				
Before January 1, 1875,	641	255	190,016	$160,139 00	$16,013 88	$144,125 12
Up to January 1, 1876,	1,138	743	349,216	357,682 26	35,768 20	321,914 06
Up to January 1, 1877,	2,415	879	561,692	525,228 21	52,522 82	472,705 39
Remaining to be done,	165	68	284,308	195,206 79	–	–
Total when done,	2,580	947	846,000	720,435 00	–	–
Add cost of platform, if built,	–	–	–	75,000 00	–	–

BOSTON, January 2, 1877.

HISTORICAL NOTES ON PLYMOUTH HARBOR.

[Furnished to the Board in advance of its publication elsewhere, under authority from the Superintendent of the U. S. Coast Survey.]

BOSTON, May 1, 1876.

DEAR SIR:—I desire to call your attention to evidences of important physical changes in the harbor of Plymouth, which are furnished by comparisons of Champlain's sketch (1605) and Blaskawitz's survey (1774) with the most recent chart of the Coast Survey.

The first of these documents is found in the published works of Champlain; the second is before me, in the original manuscript, bearing the autograph of the author, with his official title, "Deputy Surveyor for North America."*

Champlain.—The sketch of Plymouth under the name of *Port St. Louis*, may be found in Chapter VIII. of the Quebec edition.†

From the text it appears that the little vessel bearing Champlain (who was not the commander) ran into the "*cu-de-sac*," to wait for a fair wind to continue the voyage, on the 18th of July, 1605, and remained there only one day.

The positions are given upon the sketch of two anchorages, one in the middle of the roadstead, which was the first occupied, the other near the point of Long Beach. They were tempted to leave their first anchorage by the hope of going in their vessel into the "river," to which they were invited by the Indians; but they found the water too shallow, "it being low tide," and again let go their anchor.‡ This vessel drew five feet, and the sounding given on Champlain's sketch, indicating the end of the course, is one fathom; from which we learn that his depths are reduced to low water. Champlain went on shore and reconnoitred the river, and found it only an arm of the sea. He describes the bay as a place about one league in circuit—evidently meaning the "*cu-de-sac*" into which the vessel ran for an anchorage, and not the entire water-space. It is this "*cu-de-sac*" that he sounded out, and although he does not represent Brown's Bank, the limits of his soundings indicate that the bank was there, but that he did not know that any ship channel lay between this bank and the Gurnet or Saquish. If this bank had been as elevated as it now is, so as to run dry at low water, he would probably have represented it on his sketch, and have guessed that the great entrance channel to interior waters lay beyond.

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* This manuscript map of 1774 is the property of Mrs. Mary Winslow Russell, grand-niece of the Edward Winslow to whom (as stated in the legend) it was presented by the author. This map has never been published, although the late Dr. Nathan Hayward, some ten years ago, made lithographic copies for private distribution.

† *Œuvres de Champlain publiées sous le patronage de L'Université Laval, par L' Abbé C.-H. Laverdière, M. A.*, 1870.

‡ Presuming that Champlain's date is Gregorian, we have computed the tide, and find that low water, a little below the mean, occurred at 6 P. M.

In the text he refers to the Gurnet as covered with wood, principally pines, and as "attached to a pretty long coast of sand dunes."

He then speaks of two "*islets in the said bay*" (evidently Saquish and Clark's islands), "*which are not seen unless one is within, around which the sea runs nearly dry at low tide.*"

Champlain's map is, in the main, a wretched eye sketch—one of the worst that appears in his narrative. He evidently did not think the anchorage a valuable one. He had gone in on the wrong side of Brown's Bank, and just missed the discovery of an excellent harbor.

Ignoring the well-deserved reputation of this very scrupulous explorer and writer, and assuming nothing for this map beyond that which would impress us in the most ordinary sailor's sketch, we still must admit that there are points of value in it. He had two instruments, a compass and a lead-line, and he evidently designed to represent two positions of his vessel in their relations to the two entrance headlands, etc.

With his compass corrected for the variation, determined by him at *Malle Barre* on the previous voyage, we find the tangents to the entrance headlands (at the shore lines) to be N. by E. one-half E. and E. S. E., while the point of Long Beach bears N. W. (true). We also observe that a considerable portion of Clark's Island is open to the westward of Saquish.

With these bearings and range, we plot the vessel upon our Coast Survey map, and find it lying two miles from Rocky Point, and over three from Gurnet Point. These two points have no doubt washed away somewhat; but with every possible allowance for waste, we cannot conclude, from the data referred to, that the anchorage place was less than one and three-quarters statute miles from the outer chord of the entrance. In his sketch, however, Champlain makes the vessel lie about mid-way between the outer chord and Long Beach, which would reduce the distance we have just given to one and a quarter miles.

Having satisfied ourselves that the vessel lay from one and a quarter to one and three-quarters miles from the entrance, let us examine the soundings he has grouped about her and extended seaward in his sketch. We find that in the circle of a half mile diameter, about the vessel, there was an average of seven and one-half fathoms—the extremes being five fathoms, on the inside, and nine fathoms on the outside. The same circle upon the Coast Survey Chart shows a mean of about three fathoms, and nothing greater than four fathoms in 1853.

Again, we find that from his anchorage, nearly to the chord of the bay, he has numerous soundings showing that a belt, about a half-mile wide, could be followed out of the bay with a depth of nine fathoms, and that when still quite within the tangent chord of the bay (so as to be in the narrowest part of the entrance) there were ten where there are now less than six fathoms. You will observe by consulting Champlain's sketch, that he gives four soundings of ten fathoms in this neighborhood, as if to *make sure* to represent the entrance depth to this "*cu-de-sac.*"

In the subjoined table we give a comparison of his soundings with those of the Coast Survey in 1853—the latest we have :—

DISTANCE FROM ENTRANCE.	DEPTH IN FATHOMS.		Loss of Depth.
	1605.	**1853.**	
Statute Miles—			
0.00,*	Not given.	5¾	–
0.25,†	10	5¼	4¾
0.50,	9	4½	4½
0.75,	9	4½	4½
1.00,	8	5	3
1.25,	7	3½	3½
1.50,	5	3½	1½

* Tangent line from Gurnet to Rocky Point.

† Between entrance headlands.

It is safe to conclude from the above, that the deeper portion of the cove or bay between Brown's Bank and Rocky Point, has received an enormous deposit since the visit of Champlain.

As well as we can judge from the sketch, the depth found near the point of Long Beach was about the same in 1605 as it now is, although there can be no doubt that alterations of Long Beach itself have been in progress since that time.

There is no evidence of any general emergence of the New England coast indicated by any comparisons that we have made of Champlain's maps with those of the Coast Survey. Salt marshes indicated by Champlain in his map of Saco, Maine, are marshes still, and the depths over the rocky bottom of Gloucester, as well as in some of the lagoons of Cape Cod, remain the same now as in 1605. The Old Colony Records of very early dates abound in references to the salt marshes of Plymouth, Duxbury, and Marshfield, which were peculiarly valuable in a country where the uplands were not yet cleared, and which still remain at level of high water. We have taken pains to investigate a little this question of emergence, because a very able geologist has recently asserted that the coast of the "Gulf of Maine" rises from one to three feet per century.

Blaskawitz (1774).—In its topographical features, the original plotting made by Blaskawitz from his survey of Plymouth, is remarkable for accuracy and beauty. It is deficient in soundings, but the depths in the principal channel-ways are given, and seem to be designed to be those of the best water at low tide.

The depths in the channel through the Cow Yard and along the main ship channel past Saquish Head, are represented much less in 1774 than upon our latest Coast Survey Chart. It is possible that the completion of the cordon of dunes connecting Saquish with the Gurnet (which has been effected since the Blaskawitz Survey) and the closing of a broad *wash-over* in the beach above Rousse's Hummocks, may have caused more water to flow in and out of the channels we have named, and induced a greater depth of water.* But we should be timid of conclusions relative to *deepening*, because our Coast Survey soundings are so much more numerous than those upon the old map, that the greatest depressions of the channel-bed are more likely to have been reached by us than by Blaskawitz.

When shoaling, instead of deepening, is indicated by the comparison of old maps with our own, we may safely conclude that a change has occurred, and this is the case presented in the lower part of the main ship channel between Saquish and the sea, to which we shall now refer.

The following table shows the comparison of depths in the lower reach of the main ship channel:—

Distance in Statute Miles.	Depth in Fathoms.		Loss of Depth.
	1774.	1853.	
1.00,	6	4½	1½†
0.80,	7	4¼	2¾
0.60,	8	4½	3½
0.44,	9	4¼	4¾
0.25,	9	4½	4½
0.00,	10	4¾	5¼‡
0.20,	10	6	4 §

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* This opening above Rousse's Hummocks appears to have been dry at low tide—and is a little uncertain in the manner of its representation.

† One mile westward from tangent line, joining outer cliff of Gurnet with Rocky Point.

‡ On tangent line, joining outer cliff of Gurnet and Rocky Point.

§ Outside of tangent line above mentioned.

General Conclusions.

1. Champlain entered the outer cove of Plymouth, in 1605, with ten fathoms of water where there are now less than six; and Blaskawitz, in 1774, ran into the main ship channel of Plymouth with ten fathoms where there are now less than five.

2. Champlain, in 1605, found about four fathoms more water in the deeper portion of the outer cove than now exists; and Blaskawitz, in 1774, found about four fathoms more water, for a distance of a mile, in the outer portion of the main ship channel, than now exists.

It would be rash to conclude that the agreement of these diminutions of depth indicates that the entire change has occurred during the last century; but we drop this hint for what it is worth.

Along the western coast of Cape Cod Bay there are several fiords similar to Plymouth, but of less extent, that have been more nearly filled up with the sands of the coast. There are many thousand acres of salt meadow in Scituate and Marshfield, which are evidently formed of silt from the outside coast, where the high glacial bluffs are falling a prey to the dash of the sea; but the headlands at the entrance to Plymouth are now so defended by the bowlders that lie at their feet, that they yield very slowly. The Gurnet headland has diminished very little since 1774, and the distance from it to Rocky Point has remained about the same.

We have generally regarded the waves as the primary agents for the supply of the material filling up the re-entrant angles of our coast, not only in their direct action upon the glacial cliffs, but also in their transporting power where they drive diagonally upon the shore; but in Cape Cod Bay there is a curious action of the currents that we must not ignore. In the report of the Advisory Council of the Joint Committee of the Massachusetts Legislature on the Cape Cod Ship Canal (1860), it is stated that "the tidal party in Cape Cod Bay discovered a coastwise current which 'gave peculiar interest to the observations.' This current sweeps along the western shore of the bay, pursuing a northwardly course; it is feeble at the outlet of the canal, but it gathers strength further north, where, according to the observations, it slackened only for about two hours at the time of most rapid rise of tide. The most singular feature, perhaps, of this coast current, that fell under the observer's notice, was its very low temperature in summer." The next year after this report of the Advisory Council was made, the same party of Coast Survey observers made further investigations upon this stream. A station was occupied only about four miles south-east of Rocky Point (the southern headland of Plymouth), and there the northerly movement was found to be about a half-mile per hour at the surface, and but little less than this near the bottom, eighty-four feet below—a velocity quite equal to the rolling of sand.

3. The material which has accumulated in the entrance to the main ship channel of Plymouth, and in the cul-de-sac below Brown's Bank, has been brought alongshore from the northward by storm seas, and has been swept from the southward, over the bed of Barnstable Bay, by a littoral current.

Very respectfully, yours,

HENRY MITCHELL, *U. S. C. S.*

CARLILE P. PATTERSON, Esq., *Superintendent U. S. Coast Survey.*

NOTE.—Copies of the sketches of Champlain and Blaskawitz will be found in the Annual Report of the Coast Survey for 1876, not yet issued. Below we give a full translation of Champlain's account of his visit to Plymouth.

"*Continuation of the Discoveries of the Coast of the Almouchiquois, and what we particularly remarked there.*

"The next day we doubled the Cape St. Louis, thus named by *Sieur de Mons*, moderately lowland, in latitude 42¾°, and made this day two leagues of sandy coast; and passing along this, we saw there a quantity of cabins and gardens. The wind being contrary, we entered into a *cu-de-sac* to await proper weather to make our route. There came to us two or three canoes, which came from fishing cod and other fish which occur there in quantity, which they fish with shafts (?) made out of a piece of wood into which they fasten a bone which they form in fashion of a harpoon and tie very carefully for fear that it should pull out, the whole being in the form of a little hook; the line which is attached to it is made from the bark of a tree. They gave me one of them, which I took from curiosity, where the bone was attached by hemp, in my opinion like that of France, and told me that they gathered this herb in their country without tillage, and showed me the height to be four to five feet. The said canoe went back to the land to notify those of his household, who made smoke (as signal?) and we perceived eighteen or twenty savages, who came to the border of the sea and began to dance. Our boat went on shore to give them bagatelles, with which they were well pleased. There came down to us others who prayed us to go into their river. We weighed anchor to do so, but we could not enter because of the little water which we found there, it being low tide, and were constrained to anchor at the entrance. I went on shore, where I saw many others, who received us very graciously, and reconnoitred the river, which is nothing but an arm of the sea, which extends a little distance inland, which is in part deserted, within which is a brook which is not navigable for boats except at high tide.

"This place may be a league in circuit. At one of the entrances of it there is a kind of island (?) covered with wood, and principally with pines, which is attached to a pretty long coast of sand dunes; the other coast is a pretty high country. (A *promontory seen four or five leagues at sea*, is the purport of the legend on the sketch.) There are two islets in said bay, which one sees not if one is not within, around which the sea nearly drains out at low tide. This place is very remarkable from the sea, inasmuch as the coast is low, except the cape of the entrance of the bay, which we named the port of the Cape St. Louis, distance from the said cape two leagues, and ten from the *Cap aux isles* (Cape Ann). It is about in the same latitude as Cape St. Louis.*

"The 19th of the month we left this place. . . ."

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* The latitude stated is 45 miles too high. If Champlain had not illustrated the above narrative by a sketch, it would, by itself, be scarcely more comprehensible than the Sagas relating to the voyages of Leif and Thorwald in the same neighborhood *probably*.

LIST OF PROPRIETORS

To whom Payment has been Made by the Commonwealth in Settlement of their Rights to Marsh Lands in East Harbor.

Proprietors of East Harbor Meadow,	$1,820 00
Thomas F. Small,	983 47
Isaac M. Small,	751 13
Jesse Collins,	65 88
J. G. Thompson,	119 39
Asa Sellew *et als.*,	28 31
Atkins Hughes,	64 96
Wm. Chandler,	27 45
S. T. Eastman,	45 60
Isaac Green,	23 18
Francis Small,	56 36
T. K. Small,	101 10
Isaac Small,	185 28
Jesse Paine,	32 94
E. C. Kilburn,	111 93
Sarah Larkin,	101 50
Solomon Bangs,	48 40
Jesse Collins,	28 06
Amos Coan,	76 86
J. S. Dyer,	96 80
John Hughes,	89 34
Heirs of J. A. Mayo,	129 62
Enos Nickerson,	77 44
Jesse Paine,	18 14
Thomas D. Smith,	100 49
Heirs of John Smith,	186 80
S. K. Hopkins,	120 32
David D. Smith,	114 06
Asa Sellew,	108 91
Heirs of James Hughes,	233 78
Heirs of J. Small,	134 50
Wm. Holden and Wm. Holden, Jr.,	283 92
Wm. Holden, Jr., and Wm. Holden,	25 16

Thomas Small,	$117 61
D. S. Small,	63 28
Heirs of Edw. Armstrong,	110 93
Edgar Paine,	83 41
Isaiah Gifford,	449 37
Joanna C. Myrick,	54 44
W. H. Collins,	47 52
D. D. Smith,	55 51
Wm. Chandler,	57 49
Francis Small,	170 92
Reuben Atkins,	170 52
Jonah Stevens *et als.*,	182 54
Seth Nickerson,	46 01
Heirs of Jonathan Nickerson,	174 24
J. P. Johnson,	65 32
Heirs of Nehemiah Nickerson,	78 65
Heirs of Simeon Conant and Eben. Atkins,	76 25
Mercy M. Lewis,	103 70
J. H. Bird,	28 97
Thomas Lewis,	133 42
R. O. Watkins,	88 08
Stephen Nickerson,	107 20
	$8,856 46

ABSTRACT OF REPORT OF GEN. GEORGE THOM TO THE CHIEF OF ENGINEERS, FOR 1876.

Improvement of Boston Harbor, Mass.

Operations for the improvement of this harbor were suspended for the winter in November last. The work done during the past season of 1876 has been as follows, viz:—

1. *At the Upper Middle Bar.*

This improvement consists in straightening, widening, and deepening the main ship channel for a distance of fifteen hundred (1,500) yards across the bar, for a width of six hundred (600) feet, and to a depth of 23 feet at mean low water, or about 33 feet at mean high water. Dredging operations were resumed at this place on the 3d of May last, by the Atlantic Dredging Company, of Brooklyn, N. Y., under contract of March 5, 1874, and continued until the 11th of July, when the contract was completed by 90,859½ cubic yards of dredging. On the 9th of May last, Messrs. Curtis, Fobes & Co., of Portland, Me., also commenced dredging at this place, under their contract of May 19, 1875, for 90,000 cubic yards, more or less, of dredging, which was continued by them without interruption until the 16th of November, when the contract was completed by 88,150½ cubic yards of dredging. On the 10th of June, work was commenced by the Harbor Improvement Company, of Boston, under contract of September 1, 1874, on the removal of several sunken ledges which were laid bare by their dredging operations of the previous year on the Upper Middle Bar; which ledges were completely removed to the required grade of 23 feet below mean low water, on the 26th of August,—containing, altogether, 37 cubic yards,—in completion of the contract.

Under the above-named contracts, together with the previous ones made and completed since 1870, *all* the *dredging* required at the Upper Middle Bar has been completed, amounting altogether to 268,278½ cubic yards; and about 50 cubic yards of sunken ledges and bowlders have been broken up and removed to grade. The only shoal part of the channel at this place which, after about 31,500 soundings, has been found to require further improvement, is a sunken *ledge* laid bare by dredging. It is about 300 yards above (westward of) black buoy No. 9, and extends 150 yards into the channel on its southern side, covering an area of about 230 superficial yards in the plane 23 feet below mean low water, with about 20 feet of water over its shoalest part at mean low water. The removal of this ledge to grade will require about 81½ cubic yards of excavation.

2. *West End of Great Brewster Spit.*

The work for the improvement of the main ship channel at this place consists in the excavation, by dredging and otherwise, of the southern portion of this spit, so as to obtain a depth of 23 feet at mean low water, for a width of not less than 600 feet. The dredging required at this place commenced in August, 1875, by the New England Dredging Company, of Boston, under contract of September 3, 1874, leaving to be done for its completion the breaking up and removal of 95½ cubic yards of ledge which had been laid bare above grade by the dredging. This work was commenced in the latter part of May, 1876, and was finished on the 8th of November; which, with the dredging (viz., 29,225 cubic yards) previously done under the same contract, has completed all the improvements projected at this place.

3. *Nash's Rock Shoal.*

This shoal lies in the entrance of Boston Harbor, about one-third of the way across from Brewster Spit to Point Allerton. It has an area of about nine acres above the 23 feet plane, and is composed of bowlders (some of which are very large), shingle, gravel, hard-pan, etc., etc. The improvement projected for this place is to reduce the shoalest portion of the shoal to a depth of 21 feet at mean low water, and to remove all the dangerous rocks from its surface. Under the contract made May 19, 1875, with Messrs. Curtis, Fobes & Co., of Portland, Me., this work was partially finished in September last, leaving still to be done, under some new contract, about 50 cubic yards of dredging, and about 100 cubic yards of bowlders to be broken up and removed.

4. *Repairs of Sea-walls.*

Sea-walls have been built for the protection and preservation of the headlands in this harbor, at Point Allerton, Great Brewster Island, Lovell's Island (north head and south-east bluff), Gallop's Island, Long Island (north head), and Deer Island (north, middle, and south heads). All these sea-walls, with the exception of that on the south-east bluff of Lovell's Island, and those on Deer Island, are in good condition. During the months of October and November, all the necessary repairs were made on these sea-walls, excepting that on the south-east bluff of Lovell's Island. For raising and repairing this wall, an estimate for an appropriation was submitted in my last annual report.

5. *Removal of Sunken Rocks.*

The removal of Kelly's Rock, Tower Rock, Corwin Rock, and of a sunken ledge recently discovered between George's Island and Great Brewster Spit (all situated in the main ship channel at "The Narrows"), had all been removed in September, 1875, to a depth of 23 feet at mean low water, as stated in my last annual report. Barrel Rock, in Broad Sound, and State and Palmyra rocks, on the southern edge of the Lower Middle Bar (about one-half a mile east of Castle Island), have also been removed; so that the only work that now remains to be done for completing all the contemplated improvements in this harbor consists of the following, viz.:—

1. Straightening, widening, and deepening the main ship channel at the south-west point of Lovell's Island, at an estimated cost of	$16,000 00
2. Completing the improvement of Nash's Rock Shoal, say	5,000 00
3. Removal of ledges recently discovered above and below Kelly's Rock, say	11,340 00
4. Removal of ledge recently discovered in the main ship channel, at the Upper Middle Bar. . .	5,000 00
5. Removal, by dredging, of Man-of-War Shoal, say	39,000 00
6. Repairing sea-wall on south-east bluff of Lovell's Island, estimated at	15,000 00
Engineering expenses, and other contingencies, say .	13,135 00
Total, ...	$104,475 00
Amount appropriated by Act of Congress, approved August 14, 1876 ($50,000), less amount since expended is, say	44,475 00
Additional amount required for completing all the contemplated improvements in this harbor, .	$60,000 00

IMPROVEMENT OF HINGHAM HARBOR, MASS.

By Act of Congress, approved March 3, 1875, provision was made for the improvement of this harbor, the cost not to exceed $10,000. The project adopted for this improvement consisted in straightening, widening and deepening the channel, so as to have a width not less than one hundred feet and a depth of eight feet at mean low water, or about six feet at low water of spring tides, the mean rise and fall of the tides being nine and a half feet.

Under a contract made with Messrs. Curtis, Fobes & Co., of Portland, Me., 25,160 cubic yards of dredging (at 18 cents per cubic yard) was done by them, which they completed on the first of May, 1876; and under contracts made with Mr. George W. Townsend, of Boston, Mass., ninety-two cubic yards of sunken ledge was removed from the channel, which was also completed in May last. This completes all the improvement projected for in this harbor.

Improvement of Merrimac River, Mass.

The project adopted for this river, consists in so improving it by dredging and the removal of sunken rocks, that it shall have a depth of twelve feet at ordinary high water, from its mouth in Newburyport Harbor, Mass., up to Haverhill (a distance of fifteen miles); and thence for a distance of about four miles up through "the falls," a depth of four feet in the ordinary stages of the river. During the past season, work has been carried on, for this purpose, as follows; viz.:—

1. The channel has been opened for a width of one hundred feet, and to the projected depth through "Currier's Shoal," about five miles below Haverhill, Mass.
2. The channel has been opened for a width of about seventy-five feet, and to the projected depth through the shoals, near the head and foot of Silby's Island, from one to two miles below Haverhill.
3. The shoal at Haverhill, between the bridges, has also been improved, so as to have a channel ten feet in depth at ordinary high water; and
4. Numerous large bowlders have been removed from the channel at "the falls" above Haverhill.

These operations were continued until the last of October, when they were suspended for the winter on account of freshets and ice.

These improvements, together with those made in 1875, near Rock's Bridge, by the removal of Petty Rock, Little Currier Rock and shoals above and below the bridge, have been such that the only work that now remains to be done for completing the improvement of this river above Newburyport Harbor, as now projected, consists in the removal of numerous sunken bowlders from the channel near Silby's Island and elsewhere, for which the funds now available are believed to be sufficient.

For the projected improvement in Newburyport Harbor, the additional appropriations asked for in my last annual report will be required.

PLYMOUTH HARBOR, MASS.

The improvement projected for this harbor consists,—

1. In the protection and preservation of Long Beach, which affords the only shelter the harbor has from easterly storms; and

2. In opening through the shoals a towing channel, one hundred feet in width and six feet in depth, at mean low water (or sixteen feet at mean high water), from deep water near the Middle Ground up to the wharves of Plymouth.

The various works that have been built from year to year upon Long Beach, have strengthened and extended it to such an extent as to afford all the desired protection to the harbor, with a prospect of its being permanent, if by proper and seasonable repairs it shall be kept in its present efficient condition.

Under the appropriation of $10,000 made by Act of Congress, approved March 3, 1875, for improving the channel of this harbor, a contract was made with Mr. Augustus R. Wright, of Geneva, N. Y., for the dredging, at twenty-three cents per cubic yard, which he completed in June last by 34,985 cubic yards of dredging; whereby a channel has been opened up to the wharves of Plymouth, for a width of fifty feet, to a depth of six feet at mean low water. An estimate for completing the improvement of this harbor has been submitted, with a view to obtaining an appropriation therefor by Congress.

ABSTRACT OF REPORT OF GEN. G. K. WARREN TO THE CHIEF OF ENGINEERS, 1876.

NEW BEDFORD HARBOR, MASS.

In the months of July, August, September, and October, 1875, a channel 105 feet wide was dredged from the deep water near Fairhaven wharves, across the shoal to the wharves at New Bedford.

The depth secured was 15 feet at mean low water. The mean rise of the tide is about three feet. The completed project is for a channel of the above depth 200 feet wide, for which, according to the original estimate, $4,000 additional is required.

Financial Statement.

Amount in treasury of the United States, July 1, 1875,	$10,000 00
Amount expended in the fiscal year ending June 30, 1876, ...	9,926 13
Amount available July 1, 1876, ...	73 87
Amount appropriated by Act approved Aug. 14, 1876,	10,000 00
Amount estimated to complete project, . . .	4,000 00

Dec. 1, 1876. The expenditure of the appropriation of $10,000, made by Act of Aug. 14, 1876, has not been authorized.

HYANNIS HARBOR, MASS.

There being no sufficient means available for this work, nothing was done during the past fiscal year. To complete the strengthening of the work at the breakwater, will require an appropriation of $10,000. Besides this, the lighthouse should be moved to the east end of the breakwater.

Financial Statement.

Balance in treasury of the United States, July 1, 1875,	–
Amount in hands of officer, subject to his check, July 1, 1875, ...	$42 94
Amount expended during the fiscal year ending June 30, 1876, ...	–
Amount required to complete the existing project, .	10,000 00

WAREHAM HARBOR, MASS.

The continuation of the dredging under the last appropriation, was unavoidably delayed until June 6, 1876. It has since made rapid progress, and will be completed in July. There will then be a channel up to the wharves nine feet deep at mean low water, having a width of 100 feet in the narrowest part, and throughout the greater part of the harbor 200 feet or more. The mean rise of the tide is about four feet.

Financial Statement.

Balance in treasury of the United States, July 1, 1875,	$10,000 00
Amount expended during fiscal year ending June 30, 1876,	2,975 22
Amount available July 1, 1876,	7,024 78
Amount required for completing project,	–

Dec. 1, 1876. This improvement was completed in July.

TAUNTON RIVER, MASS.

The work under the last appropriation of $10,000, approved March 3, 1875, which consisted in dredging and removing rocks from the channel, has all been completed except the removal of some pieces of blasted rock, which will be done in July. After this is done, there are shoal places and scattering rocks to be removed requiring an appropriation of $5,000. The channel is now essentially nine feet deep at mean high water, in the narrowest cuts 45 feet wide, and in others 60 feet wide. This river is not navigated at low tide in the upper part.

Financial Statement.

Balance in treasury of the United States, July 1, 1875,	$10,000 00
Amount expended in fiscal year ending June 30, 1876,	8,794 10
Amount available July 1, 1876,	1,205 90
Amount estimated to complete existing project,	5,000 00

Dec. 1, 1876. The removal of blasted rock was completed in August.

FALL RIVER HARBOR, MASS.

The work under the last appropriation has completed the projected channel to a width of 100 feet, and depth of 12 feet at mean low water. The mean rise of the tide is about $4\frac{7}{10}$ feet.

The original project contemplated a gradual widening out of the new channel to 300 feet at each end, this increased width being through a curved part of its course.

Financial Statement.

Balance in treasury of the United States, July 1, 1875,	$10,000 00
Amount in hands of officer, subject to his check, July 1, 1875,	4,386 77
Amount expended during the fiscal year ending June 30, 1876,	13,789 22
Amount available July 1, 1876,	597 55
Amount appropriated by Act of Congress, approved Aug. 14, 1876,	10,000 00

Dec. 1, 1876. The expenditure of the appropriation of $10,000, made by Act of Aug. 14, 1876, has not been authorized.

Boston & Albany Railroad Company,
Boston, November 27, 1876.

To the Honorable Board of Harbor Commissioners.

In behalf of the Boston & Albany Railroad Company, I respectfully represent that the docks and wharves of said company in East Boston, with the elevator and storehouses connected therewith, furnish at the present time a very large proportion of the facilities for the foreign commerce of Boston. I send to you herewith a plan of the Grand Junction wharf property at East Boston.

Dock No. 6, upon which the elevator is situated, has a depth of water of 23 feet at low tide. There are frequently two and there have been at times three large steamers discharging or receiving freight at the same time in this dock. The depth of the water opposite the dock, outside of the Commissioners' line and in the channel, is but about 18 feet at low tide. The largest steamers cannot therefore, at low water, pass from the dock over this bar or shoal into the ship channel.

The company which I represent have formerly dredged at their own expense in front of their docks to make them reasonably accessible. We understand that your honorable Board have caused the obstructions before the docks in other parts of the harbor to be removed and the water to be deepened at the expense of the State. The importance and even necessity of similar work at East Boston is more urgent. If at any time, when a loaded steamer was in this Dock No. 6, the elevator should take fire, with the tide nearly out, there would be no power to haul the steamer out of the dock to a place of safety. And, on the other hand, if the steamer should take fire, the elevator would be exposed to a like danger, with no means of protection.

I need not enlarge upon the nature and extent of the calamity which such an occurrence would cause, not only to the parties more specially interested, but to the reputation and commercial interests of the port.

I shall be ready to make any further representations, or furnish any additional information upon the subject, which the Commissioners may require.

What is required, is, that sufficient dredging should be done outside of the Harbor Commissioners' line to enable the steamers of the heaviest draught, when loaded, to float at low tide.

I am, very respectfully, yours,

D. WALDO LINCOLN,
Vice-President.

CUNARD STEAMSHIP OFFICE,
99 STATE STREET, BOSTON, December 5, 1876.

To the Honorable the Board of Harbor Commissioners, Boston.

GENTLEMEN:—On a recent outward-bound trip from this port to Liverpool, the mail steamship "China," after leaving her moorings at the Cunard wharves, East Boston, and proceeding out of dock, grounded on a bank in the harbor, which is situated about 150 feet to the westward of the northern corner of the Cunard wharf, East Boston. This bank has been gradually forming during some years past. It appears to consist of the natural deposit of the channel which sweeps over it, on the East Boston side of the harbor. There is only a depth of about 15 feet of water over it at low water. The "China," loaded, draws about 22 feet 6 inches. This vessel again sailed from Boston on Saturday the 25th ulto., and was on this occasion detained half an hour beyond her advertised time of sailing, because the pilot in charge of her considered the bank an obstruction to her safe navigation.

I respectfully refer to the pilot (Captain Harrington) and the harbor-master (Captain Cates) in verification of these statements, and if this application, confirmed by them, is satisfactory to your honorable Board, hereby petition that said bank may be removed by dredging.

I send with this a plan of the Cunard wharves, East Boston, showing a depth of water around them, dredged by the proprietors, of from 22 to 23 feet at low water.

Yours, very respectfully,

JAMES ALEXANDER,
Agent Cunard Steamship Company.

[Chapter 122, 1876.]

AN ACT

RELATING TO THE PASSAGE OF VESSELS THROUGH DRAWBRIDGES.

Be it enacted, &c., as follows:

SECTION 1. Any city or town in which a draw for the passage of vessels through a bridge used as a public highway and maintained at the public expense, is situated, shall have power to make ordinances or by-laws regulating the passage of vessels through such draw, and to annex penalties not exceeding fifty dollars for each violation thereof: *provided*, such ordinances or by-laws shall be approved by the harbor commissioners.

SECT. 2. In all cases where such ordinances or by-laws are made applicable to any draw, it shall be the duty of such city or town to place said draw under the direction of a suitable person or persons, as draw-tender or superintendent, and to post in some conspicuous place near by, a written or printed copy of such ordinances or by-laws.

SECT. 3. Such draw-tender or superintendent shall have full control of the passing of all vessels through the draw, shall furnish all facilities for such passing, shall allow no detention, having due regard for the public travel, and shall enforce the ordinances or by-laws aforesaid.

SECT. 4. If any vessel shall, through the negligence of the master or others having charge of her, or their neglect to comply with such ordinances or by-laws, or disregard of the directions of such draw-tender or superintendent, injure any bridge, draw or pier or wharf connected therewith, the owner or owners thereof shall likewise be liable to pay for such damage, to be recovered by such city or town in an action of tort.

SECT. 5. Such draw-tender or superintendent shall likewise have authority to remove any vessel obstructing such draw, or interfering with the passage of other vessels through the same, or made fast to such draw or bridge or pier or wharf connected with the same, without the consent of such draw-tender or superintendent, or wilfully violating any ordinance or by-law, and the expense of such removal shall be recovered in the manner set forth in the foregoing section.

SECT. 6. This act shall take effect upon its passage.

Approved April 6, 1876.